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REPORT OF THE TWENTY-FIFTH ALFALFA IMPROVEMENT CONFERENCE

JULY 13-15, 1976, CORNELL UNIVERSITY

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AGRICULTURAL RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE

REPORT OF THE TWENTY-FIFTH ALFALFA IMPROVEMENT CONFERENCE

JULY 13-15, 1976, CORNELL UNIVERSITY,
ITHACA, NEW YORK

Reported by
D. K. Barnes, Permanent Secretary

Twenty-sixth ALFALFA IMPROVEMENT CONFERENCE to be held
June 6-8, 1978, South Dakota State University

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

TWENTY-FIFTH ALFALFA IMPROVEMENT CONFERENCE

Program Chairman - M. W. Pedersen

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INTRODUCTION

The 25th National Alfalfa Improvement Conference met concurrently with the 18th Forage Insect Conference at Cornell University, Ithaca, New York. One joint half-day session was held, devoted to "Insect pests of eastern and western United States". There was also joint participation in field trips highlighting forage research at Cornell.

The conference was opened by M. W. Pedersen, Chairman of the Alfalfa Improvement Conference. Dr. Noland L. VanDemark, Director of Research, New York State College of Agriculture and Life Sciences, Cornell University, welcomed the participants. The 25th anniversary of the Alfalfa Improvement Conference was recognized in two special addresses: "History of the National Alfalfa Improvement Conference" by Clarence H. Hanson, former conference secretary; and "Soil deterioration in relation to the rapidly growing demand for food" by R. Alexander Brink, member of the 1st Alfalfa Improvement Conference.

This report contains the two special addresses, summaries of research studies reported, committee reports, business transacted, and a list of participants. From the entomological standpoint, this report covers only the session held jointly with the entomologists. A complete report of the Forage Insect Conference is being prepared by Arthur A. Hower, Jr., Department of Entomology, Pennsylvania State University, University Park, Pa. 16802.

Speakers and their organizations are responsible for the information they have contributed to this report and do not necessarily represent the views of the U.S. Department of Agriculture. They should be consulted by those who wish to reproduce the reports, wholly or in part.

Members of the Executive Committee of the 25th National Alfalfa Improvement Conference follows. M. W. Pedersen, Chairman, Logan, UT; E. T. Bingham, Madison, WI; A. M. Decker, College Park, MD; I. J. Johnson, Manteca, CA; M. K. Miller, Fresno, CA; R. P. Murphy, Ithaca, NY; R. H. Ratcliffe, Beltsville, MD; and D. K. Barnes, Permanent Secretary, St. Paul, MN.

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Copies of this report are available from:

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History of the Alfalfa Improvement Conference

C. H. Hanson, Retired
National Program Staff
Agricultural Research Service
U. S. Department of Agriculture

I appreciate your invitation to speak at this aniversary meeting of the conference. It is an honor I share with Dr. Brink, who attended the first meeting of the Conference. It is most appropriate that we pause to give recognition to a crop that has become one of our principle sources of renewable wealth on this continent. Today I shall attempt to summarize by describing the evolution of some ideas and trends in the 25 conferences held-to-date.

At a preliminary meeting held in February 1934 at Madison, Wisc., the possibilities of integrating the alfalfa improvement work at several State Experiment Stations and the U.S. Department of Agriculture were discussed. This group recommended that "In view of the fact that current alfalfa problems are to an unusual degree regional in character, and there is the utmost need for economy in the use of public funds, it is suggested that a conference of the workers interested in pathology and breeding of alfalfa be held at Lincoln, Nebraska, in the latter part of May or early in June, 1934." My review also detected the impact of an even earlier alfalfa conference held January, 1930 in the Office of Forage Crops and Diseases at Washington, D.C. The report of the 1930 conference contains accounts of (1) Mr. Westover's trip to Europe and Turkistan which was made for the purpose of collecting alfalfas with resistance to bacterial wilt, (2) role of subsoil moisture and temperature in stand losses, (3) alfalfa problems in the Mississippi Delta, Blacklands of the South, and in Western Kansas, (4) varietal variation in resistance to bacterial wilt, and (5) a map showing distribution of wilt in the U.S.

Eighteen years later at the 11th Conference held in 1948, H. M. Tysdal reviewed and stated the goals of the Alfalfa Improvement Conference as follows: "Through a cooperative integrated program to exchange information and materials with the objectives to (1) develop, test, and establish, and (2) preserve and make available on a national basis, superior alfalfas for the maintenance of a permanent agriculture and for betterment of the seed, forage, and livestock industries for this and other countries." Personally, I know of no group that has worked more harmoniously together and that has been more successful in achieving its goals. Good cooperation is most important for several reasons. Seed production, for the most part, occurs in regions other than those where the seed is used for forage production. Alfalfa is an introduced, cross-fertilizing, self-incompatible, perennial autotetraploid containing tremendous quantities of genetic variation for molding into vigorous varieties with appropriate kinds of disease and insect resistance, and adapted to specific ecological niches. Furthermore, evaluation requires several harvests in each of several years. Development of new information and improved germplasm is complex and costly in terms of most crops, and requires integration of effort and good cooperation for greatest effectiveness.

The remainder of my presentation today deals with generalizations on conference highlights and trends as they relate to certain problem areas.

Seed Multiplication. In 1935, the Conference pinpointed nationally some problems in seed production in a recommendation or resolution sent to the Secretary of Agriculture. The Department of Agriculture subsequently increased its support for seed production. Beginning at the first Conference and continuing to the present, harmful insects, such as Lygus bugs, chalcids and others, pollinators, seeding rates and other cultural practices appear often on conference programs in connection with improving seed yields. When the first variety, Ranger, was released in 1942, modifications of seed certification guidelines were discussed by alfalfa workers and then with I.C.I.A. officials. This resulted in procedures for seed production in Utah and other states outside of the variety's area of adaptation. DDT, when it became available for Lygus control after World War II, gave seed production another shot in the arm. But it was not until initiation of the National Foundation Seed Project in 1948 that basic seed stocks became plentiful and seed production in the Far Western States became a highly specialized and economical enterprise. In 1954, the Conference scheduled a 2-1/2-day field trip in the Central Valley of California to observe the newly developing alfalfa seed industry. Seed production in Kern County alone had increased from 50 thousand in 1949 to over 14 million pounds in 1953. Seed of Vernal, released in February 1953, was increased to 2 million pounds by late 1954. Successful production of alfalfa seed led to an expansion in alfalfa breeding by industrial firms. In 1962, the Conference scheduled field trips and discussions in California to visit commercial programs. In 1960, at the request of the Eastern Alfalfa Improvement Conference, the Joint Alfalfa Work Conference was called to bring together representatives from the national Alfalfa Improvement Conference, seed industry, I.C.I.A., State Agricultural Experiment Stations, and the U.S.D.A. The purpose of this work conference was to discuss pertinent matters pertaining to publically and privately developed varieties, to delineate any interrelated problems of special concern to seedsmen and public institutions, and to enhance continued good cooperation among public and commercial plant breeding research groups. The Work Conference developed recommendations for germplasm exchange, testing programs, and seed certification. The last included a proposed National Certified Alfalfa Variety Review Board. This Board first met in 1962 and annually since, and now also works closely with officials of the Variety Protection Act. Formal release of disease and insect resistant germplasm provided an additional bridge among workers in public and private agencies. Thus we have seen a chain of new opportunities for the seed, forage and livestock industries which have evolved with technological advancements. (Admittedly, many seed problems remain to be resolved.)

Trends in Conference Programs. In the early conferences considerable attention was given to winter hardiness, standardizing testing procedures, as well as breeding and genetic techniques, and resolving specific disease, insect and other production problems. Regional tests were established and first coordinated at the national level. Then in 1952, the responsibility for coordination was shifted to the regional level.

Some geographic areas of bacterial wilt infestations and sources of plant resistance were known before 1934. The Conference provided stimulation for

developing high quality, adapted, wilt-resistant varieties and combining these traits with resistance to other diseases and insect pests. Over the years we have seen a shift to more sophisticated and in-depth programs. Conference topics have shifted from meeting to meeting to include latest findings in physiology and management, breeding, forage quality, new disease and insect pests, biological races, sterility and incompatibility mechanisms, polycross vs. S_1 and other forms of progeny testing, control of inbreeding, new sources of resistance to disease and insect pests, procedures for evaluation, autotetraploidy and its implication in breeding, causes for variation in coumestrol, saponin and other chemical constituents and their interrelationships, photosynthesis, growth models, breaking yield barriers, bloat, etc. We learned that recurring mass selection was very effective for developing resistance to many disease and insect pests, and at the same time preserve genetic variation for unselected traits. Technological advancements contributed in a major way to the increase of alfalfa acreage in the U.S. which is now more than a third of the world total. We have had fires to put out, such as the spotted alfalfa aphid and the alfalfa weevil. You rose to the challenges.

We have seen some shifts in the composition of conference participants. Canadian workers became an official part of the Conference in 1950. Since that time, we had the opportunity to hear more from our Canadian colleagues and to visit research programs that have attracted attention nationally and internationally. Joint meetings with the Forage Insect Research Conference were inaugurated in 1964. The Conferences have complimented each other to a greater degree than was possible when they met separately. Certainly the Alfalfa Improvement Conference has benefitted from this association. In 1968, we met jointly with the Technical Alfalfa Conference (dehydrators). We have noted that as we shifted emphasis to highlight new developments in specific disciplines, the composition of participants also shifted. So although business matters are now handled mostly in committees to give more time for research reports at the general meetings, it has become increasingly difficult to adequately accomodate the various disciplines represented in the Conference. Should some simultaneous sessions be considered in addition to those of the entomology group? Are there other ways by which the Conference program can better accomodate the interests of all its participants?

Looking back, we witnessed the rise of alfalfa as a feeble immigrant to one of the greatest forages of the western hemisphere. We should not forget, however, the implications of being an immigrant. We need only to recognize the environment under which alfalfa evolved - quite different from most areas where alfalfa is grown in the U.S. - to appreciate the potential problems of production. I am thinking primarily of new diseases and insect pests. This does not worry me as long as we recognize the need to be prepared with strong on-going programs. Alfalfa has a tremendous reservoir of concealed, as well as apparent, genetic variation, which largely results from alfalfa being cross-pollinated, self-incompatible, and autotetraploid in nature. There is ample raw material for the plant breeder, and he is learning how to preserve and utilize it effectively.

Before leaving this podium, I wish to express my gratitude for your tremendous cooperation during my term as chairman of the Conference, and 14 years as Secretary. Thanks also go to all of you who served as authors or coauthors

or assisted in other ways with ALFALFA SCIENCE AND TECHNOLOGY. The monograph was highly successful. A second printing was necessary in about 1974. I have just received word that the monograph is to be translated for publication in Spanish. Finally, it was a pleasure working with those of you who served on the alfalfa review board.

Soil Deterioration in Relation to the Rapidly Growing World Demand for Food[1]

R. Alexander Brink
Professor Emeritus of Genetics
University of Wisconsin
Madison, Wisconsin

Introduction

The National Alfalfa Improvement Conference was organized in 1934 at Lincoln, Nebraska, mainly to serve the collective interests of a few alfalfa breeders. An impelling factor in its formation was the advent of bacterial wilt, a soil borne disease described by the late Fred R. Jones, which was destroying alfalfa over wide areas. Eventually the wilt problem was effectively met by the development of resistant varieties, and the position of alfalfa as the prime perennial forage crop in the United States was maintained.

My interest in the plant was aroused in the 1920's by the devastating losses that periodically occurred in one or another part of Wisconsin from winter injury. Wisconsin, with its large cattle population, was a feed deficit area. Winter losses of the alfalfa crop added greatly to the bill for purchased concentrates. It was recognized that the development of a variety more winter hardy than Grimm, then in wide use, could significantly reduce dairy cattle feed costs. The need for a breeding program became urgent, of course, when Fred Jones showed that bacterial wilt, interacting with winter injury, would kill any alfalfa then available.

Another factor that early stimulated my interest in alfalfa improvement was the key role that this plant could play in controlling soil erosion on sloping cropland. Durability of the stand was a cardinal consideration in this relation, and the imperative need for a long-lived alfalfa was impressed on me by the conditions that existed in southwestern Wisconsin 50 years ago.

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[1] A luncheon address at the 25th Anniversary Meeting of the National Alfalfa Improvement Conference, Cornell University, Ithaca, N.Y., July 13, 14, 15, 1976.

Soil erosion was becoming recognized as a major problem in 17 southwestern Wisconsin counties, which were not glaciated during the Pleistocene Period. Much smaller adjoining areas in Illinois, Iowa and Minnesota had been similarly bypassed by the advancing ice. This so-called Driftless Area, which comprises about 4.5 million acres of farmland in Wisconsin, is deeply dissected. The slopes are often long and steep. The soils of the upper plateaus are fertile but shallow over the limestone bedrock. The widespread occurrence at that time of deep gullies throughout the area was dramatic evidence, even to the casual passerby, that gross soil losses were occurring as a result of concentrated water runoff after snow melt and summer thunder storms.

O. R. Zeasman, of the Wisconsin College of Agriculture staff was a pioneer in the adaptation of engineering devices to lessen erosion on sloping land in the Driftless Area. He and E. R. Jones (no relation to Fred R.) of the Agricultural Engineering Department, were instrumental in the early 1930's in organizing an informal seminar that met evenings from time to time on the Madison Campus to discuss soil erosion problems. George Wehrwein of the Agricultural Economics Department, an ardent student of land use, also was an active participant. It was my privilege to attend these meetings. Engineering measures were in the forefront of the discussions, but there was active and enthusiastic support in the little group for the breeding program that Fred Jones and I were getting underway for the development of a winter hardy, bacterial wilt resistant alfalfa and that eventually led to the commercial introduction of the Vernal variety in 1954.

I mention these bits of Wisconsin agricultural history as background for what I wish to say later about the current necessity for greatly extended soil protection measures, including the optimum use of perennial legumes and grasses.

The Present Problem

The contemporary problem with which I shall be concerned is how the needs for food and feed can be met in the face of an explosive increase in world population without destroying the soil base on which production of these necessities depends. The issue has been largely kept at bay down through history by shifting, often by conquest, to other territory as the soils of the old were exhausted. The problem, however, threatens to become dangerously acute in our time because this evasion no longer works; there are now few, if any, virgin, high-grade soils in the world to which to turn for additional agricultural products. The remaining new land is often of marginal quality and requires expensive improvements to be made agriculturally productive. Meanwhile the demand for food soars as world population increases about 80 million persons per year.

Evidence will be presented a little later showing that in response mainly to expanding market forces in industrial countries the pressure on soils for food and livestock feed has already reached a level at which serious losses by erosion are occurring. A more ominous threat than the increasing demand from the industrialized nations is the rapidly expanding food requirement of Third World countries with their already enormous, and still soaring populations. The ability of many of these economically underdeveloped countries to feed themselves is now marginal, so that simultaneous, wide-spread crop shortfalls in them could result in calls for relief from outside of unprecedented magnitude.

We have fallen behind in recent years in accommodating ourselves to these rapidly changing conditions. A comprehensive program in soil erosion control was inaugurated in the United States in the 1930's. It is one of the most important conservation developments in our history. There are unmistakable signs now, however, that the program is becoming inadequate to protect our soils from unacceptable losses. The inadequacy, to a large degree, is one of scale. As a result of mounting pressures on the land, the need for soil saving measures is considerably outrunning the capacity of conservation agencies, as now financed, to meet it. The first step in securing remedial action is arousing public recognition of this fact. Circumstances have greatly changed since an organized soil conservation program was begun about 40 years ago.

The 1930's was a period of great economic distress. The nation was in the throes of an acute depression which was greatly aggravated in the case of agriculture by widespread and intensive drought. The southern Great Plains, in which millions of acres of range land had been plowed up for wheat production during World War I, had become the Dust Bowl. Sun-obscuring dust storms swept from there to the eastern seaboard and beyond. The dust was visible and irritating and it brought to general public attention the fact that an unprecedented disaster was occurring; over a large area the soil was blowing away. The skies of Washington were darkened on occasion, and Congress was aroused to action as dust infiltrated its working quarters. New legislation was enacted that was of the utmost importance for American agriculture and the general welfare. A Soil Conservation Service was established in the Department of Agriculture in 1935 to formulate and carry out a national program of soil erosion control. The Standard State Soil Conservation Districts Law, providing for joint action with the states, followed in 1937. Work relief for the unemployed was joined by supplementary legislation to the early conservation programs that were promptly developed in the field.

Social and economic conditions are very different now as we survey the prospects for gaining the public support needed for a greatly extended soil conservation program. Our society has become largely urban, and is much more concerned with what food costs than with the problems that beset the industry that grows it. The skies are not now darkened with dust from the Great Plains and the large gullies once common in the Cotton Belt of the old South and western Wisconsin, for example, have long since been stabilized. But there are new and greater threats to our soil base. To what extent is the public aware, for example, that corn and also soybeans are now being grown, in response to current market forces, on millions of acres in the United States not naturally adapted to row cropping and that still await the protective measures that can save them from eventual destruction under this regime? Is it sufficiently understood that serious overstress on our soil resources is resulting from rising exports of coarse grains for livestock feed to satisfy a growing demand for meat in the diets of the industrialized nations of Europe and Asia and also the preference of Americans for grainfed marbled beef? As for the hungry multitudes of the Third World, are they not far away and so beset with political, economic, and social problems so alien to our experience that we can scarcely visualize their plight or understand their increasing criticisms of our consumption patterns? These are the kinds of questions that brought me here today.

Soil Losses in Dane County, Wisconsin Watersheds

I wish now to report on a recent study made in Dane County, in southcentral Wisconsin, in which the soil losses occurring in a cropping system in which corn is a major component were estimated. It will be seen that much soil damage is occurring. Furthermore, there is reason to conclude, as noted later, that the findings are indicative of the losses in other regions of the United States where corn (or soybeans) is being grown on sloping land.

I am indebted to two Madison acquaintances, J. Densmore, formerly of the Soil Conservation Service, and Greg Hill, for access to these unpublished data. Densmore and Hill are now on the staff of the Dane County Soil and Water Conservation District cooperating with the Environmental Resources Division of the Dane County Regional Planning Commission. I have had the benefit of their extensive experience in soil conservation in interpreting their survey data. It is understood, however, that I alone am responsible for what is said here relative to the policy issues involved.

Five watersheds were included in the study, four in the glaciated eastern part of Dane County, and one in the unglaciated, or Driftless Area. This is a farming region with large numbers of cattle and hogs. Corn, alfalfa, and oats are the leading crops. Two especially noteworthy changes in the farming pattern have occurred in recent decades. First, here as elsewhere in the state, there has been a marked increase in the acreage of corn, most of it at the expense of oats. Secondly, large-scale farming and custom machine service have increased lately throughout the area. A farm family may own and operate a 160 acre farm and also rent the cropland on five, or even more, farms nearby.

Densmore and Hill used a standard Soil Conservation Service technique in the survey. Eighteen or more quarter sections were randomly chosen for study within a watershed. Soil type, degree of slope, length of slope, and the current crop were recorded. The farmers were interviewed to learn the rotation and tillage practices employed.

Soil losses resulting from erosion were estimated using the Universal Soil Loss Equation routinely employed by the Soil Conservation Service. This multi-term equation is based on the results of 30 years of research in different parts of the United States on the factors that affect soil erosion such as degree and length of slope, soil type, crop rotation, tillage methods, rainfall pattern, conservation practices, and the like. Data on these factors were gathered on 160-acre blocks comprising 9-28 percent of the total area in each watershed. Estimates of the soil losses from erosion were obtained for each sampled area within a watershed by feeding the observations into the Universal Soil Loss Equation. The result is expressed as tons of soil, per acre, per year.

Distribution of Land Between Crops

Summary data for the five watersheds are brought together in table 1. As shown in the second column of the table, the proportion of farm land used for crops is 2/3 or more in four of the five watersheds. The value is only 57% for the Mt. Vernon watershed, which is in the Driftless Area. Fourteen percent of the Mt. Vernon watershed is in woodland, and 21% is in permanent pasture.

A striking fact on distribution, as shown in column 3, is that corn now occupies 1/2 or more of the cropland in 4 of the 5 watersheds. This is an increase from about 1/3 10 years ago. The highest value, that for Maunesha River, is 76%. The amount is only a little less, namely 70%, for the Door Creek watershed. The lowest value for corn land in the series is 34% for the Mt. Vernon watershed in the hilly, Driftless Area.

Note from table 1 also that the percentages of cropland used for hay and rotation pasture in the several watersheds are in reverse order to those for corn. Maunesha River and Door Creek, which have 76% and 70%, respectively, of the cropland in corn devote only 12% to hay and rotation pasture. The proportion of cropland in hay and rotation pasture reaches its maximum in the Mt. Vernon watershed where the value rises to 57%.

Nowhere does the acreage of oats exceed 12%, and it falls to 4% in the Door Creek watershed.

Estimated Soil Losses

Let us now consider the estimated soil losses from erosion in the five watersheds.

The soil loss values vary widely from one sampled 160-acre area to another in each of the watersheds. Because of the high dispersion, and the irregularity of the distributions the estimated soil loss for each sampled area is entered separately in figure 1.

The amount of soil lost by erosion that is considered tolerable varies with the effective depth of each soil type. Obviously, it is higher for deep soils than in the extreme case of a shallow soil over bedrock. Each soil in Door County has been assigned a tolerated or allowable soil loss value by the Soil Conservation Service based on the amount of erosion that it can tolerate and still remain productive. These so-called "T" factors ordinarily vary from 1 to 5 tons per acre per year.

An average T factor for the cropland in each of the five watersheds was determined based on analysis of the soil types of the quarter sections sampled. These values varied from 2.8 tons per acre per year for the Mt. Vernon Creek watershed to 4.0 for the Maunesha River and Sixmile Creek watersheds. The solid triangles on the soil loss scale in figure 1 mark the average tolerance values for the five respective watersheds.

Sixty-five, or 70 percent, of the 93 quarter sections sampled in the five watersheds gave estimated soil losses above the corresponding tolerance levels. The average allowable soil loss (T) factor for the five watersheds is 3.6 tons per acre per year. If effect is given to the amount of loss in individual cases, then the aggregate soil loss for the 65 entries in figure 1 that are above the respective allowable levels exceeds the water by 4.8 tons on the average. That is to say, more than twice as much soil (3.6 + 4.8 tons) is being lost on 70 percent of the quarter sections sampled as is consistent with proper land management.

TABLE I

DISTRIBUTION OF CROPLAND AND ESTIMATED SOIL LOSSES IN FIVE DANE COUNTY, WISCONSIN, WATERSHEDS

Data from J. Densmore and G. Hill, Dane Co. Soil and Water Conversation District in cooperation with the Dane County Regional Planning Commission

Watershed	Cropland					Estimated Soil Losses	
	Percent of Total Farmland	Corn	Hay & Rotation Pasture	Oats	Other Crops	Tons/Ac./Year Avg.	Tons/Ac./Year Highest 1/4 Section
Maunesha R.	80	76%	12%	8%	1%	5.9	13.7
Door Cr.	66	70%	12%	4%	4%	8.6	24.8
Sixmile Cr.	76	61%	27%	5%	4%	7.5	20.6
Pheasant Br. Cr.	79	50%	35%	12%	2%	6.5	12.0
Mt. Vernon Cr.	57	34%	57%	7%	0%	5.2	16.0

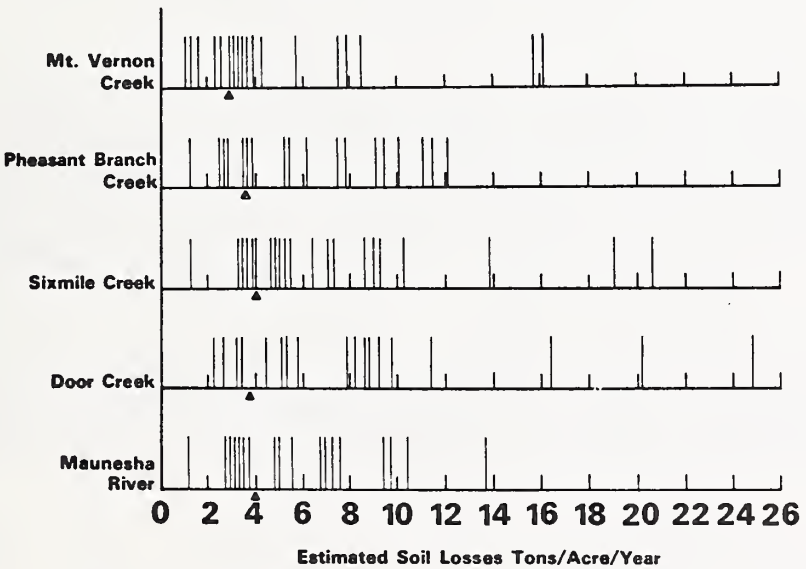
Mt. Vernon Creek
Pheasant Branch Creek
Sixmile Creek
Door Creek
Maunesha River
0 2 4 6 8 10 12 14 16 18 20 22 24 26
Estimated Soil Losses Tons/Acre/Year

Figure 1.--Estimated annual soil losses by erosion on cropland in five intensively farmed watersheds in Dane County, Wisconsin. Each vertical line represents one randomly chosen 160-acre sampled area. The five solid triangles mark the respective estimated amounts of erosion that the soils can tolerate and still remain productive (Data from J. W. Densmore and G. A. Hill, Dane County Soil and Water Conservation District cooperating with the Environmental Resources Division of the Dane County Planning Commission).

The Mt. Vernon Creek Watershed

The Mt. Vernon Creek watershed is a special case because it lies within the Driftless Area where the soils are shallow over bedrock and the slopes, in general, are steep.

This watershed has the lowest average estimated annual soil loss for the five surveyed, namely 5.2 tons per acre. Note from figure 1 that the soil loss values for cropland in 12 of the 18 quarter sections sampled in this watershed are clustered toward the lower end of the scale. In only 2 of the quarter sections sampled are the losses severe. The values in these cases are 15.7 and 16.0 tons, respectively.

Because of the steep topography of the area and the nearness of bedrock to the surface, the soils in the Mt. Vernon Creek watershed are the most subject to destruction under row cropping. Why then does this watershed make the best showing among the five surveyed. The answer is meaningful.

The Driftless Area of southwestern Wisconsin since establishment of the Soil Conservation Service 40 years ago has been the scene of a major research and educational effort in soil stabilization. The action program there has transformed the region from one in which soil deterioration by sheet erosion and gully formation formerly was widespread to an area in which farming in accordance with sound conservation principles is now common.

The favorable showing of the hilly Mt. Vernon Creek watershed in the survey affords no grounds, however, for complacency. The pressures to increase the acreage of row crops even in the Driftless Area must not be underestimated. A recent tabulation of Wisconsin Statistical Reporting Service data shows that the acreage of corn for grain and silage for the 7-county district in extreme southwestern Wisconsin, all within the Driftless Area, rose from 420,000 to 520,000 in the 20-year period 1954-1974. This approximately 25% increase took place mainly at the expense of oats. During the same period the harvested acres of hay (mainly alfalfa) had risen only 9%. There is a tendency also, as the size of farms and machinery increases, to disregard strip cropping and terracing as inconvenient. Soil conservationists familar with the area have expressed the opinion to me that with the significant shift to corn in this hilly region the measures needed to protect the soil against erosion have not kept pace. A consequence is that soil losses are now increasing.

The figures given for estimated soil losses in 5 watersheds in Dane County, Wisconsin, are probably indicative of what is happening over large areas of cropland in the United States. Evidently the data are not extreme. Wm. Brune, SCS state conservationist for Iowa, for example, recently estimated that the average annual soil loss on sloping unprotected cropland in that state is 13 tons per acre. That is about 2 bushels of soil for each bushel of corn harvested on this land. Brune reports that in 1974, a disastrous erosion season in Iowa, soil losses of 40-50 tons were not uncommon.

The Growing Demand for Food and Feed

Let us now briefly examine the general outlook for food. Two sets of factors are likely to keep the demand for North American grown cereals and soybeans high in the years just ahead. They are (1) the large requirement at home and in other industrialized countries for food and especially for livestock feed, and (2) dependence of Third World countries on the United States and Canada for relief in emergencies as their soaring populations outrun local food supplies.

The average American uses nearly a ton of grain a year. Ninety-three percent of this is utilized indirectly by feeding to cattle, hogs and chickens for meat, milk and eggs, our main protein sources. Rising standards of living in other industrialized countries have led to increases in meat consumption. The amount of meat used in France, the United Kingdom, West Germany, Italy, and the U.S.S.R., for example, increased 31 percent between 1960 and 1970. The rise in Japan, with its 112 million people, for the same period was 264 percent (Rensberger, B., 1975, in Give Us This Day . . . A report on the world food crisis, p. 237, New York, Arno Press). Our much publicized grain sales to the Soviet Union in 1972 resulted from that government's decision to maintain the level of meat consumption in spite of a poor cereal crop at home. The United States and Canada are now the sources of about 80 percent of the food and feed grains the industrialized nations import.

The dollar value of U.S. agricultural exports, as shown in Figure 2, rose from about 5 billion in 1970 to 20 billion in 1974. Note that nearly all agricultural exports are now on a commercial, rather than a government aided basis under Public Law 480. Twenty-four percent of our 1974 agricultural exports were wheat and flour. Forty-three percent were feed grains (mostly corn and sorghum), soybeans, and their products.

With the massive shipments abroad and rising consumption at home the cumbersome agricultural surpluses that accumulated after World War II have disappeared. Lester R. Brown (Science 190:1053-1059) estimates that the world's reserve stocks of grain dropped to a 33-day supply in 1974. We are essentially dependent, therefore, on current production.

Food Needs of the Third World

Let us now consider the meaning for us of the food needs of the economically underdeveloped and most populous nations of the world.

Until 200 years ago, that is, about the time the United States republic was founded, world population was low and comparatively stable. High birth rates were balanced by high death rates. Then an abrupt demographic change began as a result of falling death rates.

It took man from his emergence as a distinct species, perhaps 3 million years ago, until 1830, to assemble the first billion people. As has been frequently pointed out, it required only 100 years (from 1830 to 1930) to add the second billion. The third billion arrived in 30 years, and the fourth billion followed in only 15 years. About 10 years hence, barring a nuclear catastrophe or a devastating disease epidemic, there will likely be 5 billion people on the earth (See Figure 3).

This enormous population expansion is new to man's experience. Its implications for human welfare are profound. Of special concern here is the danger that the increased pressure for food will undermine our soil resources.

Demographers estimate that the billion people who will be added to the world's population in the next decade, 90 percent will be in the economically underdeveloped nations of Asia, Africa, and Latin America. How are these 900 million additional mouths, 10 years hence, to be fed?

A realist has remarked that some problems do not have solutions, only consequences. The population-food problem is one of them. It is difficult technologically, and the resulting strains on people threaten the political fabric of nations. I will advert to the latter aspect only briefly.

The most ominous general effect of the phenomenal increase in numbers of people is polarization of the nations of the world into two groups, one industrialized, rich and well fed, the other poor, and often hungry. The tensions that are arising from the widening gap between the affluent and the poor nations are a warning sign of conflict ahead. Secondly, the internal economic and social problems of many underdeveloped countries are staggering. Massive poverty and large scale migration from a deteriorating countryside to urban centers, perhaps to a shantytown in the suburbs, where employment may be sought in vain, incite political turmoil. The expansion of economic opportunity and the rationalization of social institutions are worthy goals everywhere. They are not readily attainable, however, amidst poverty. The exploding world population is pushing man in many places to the limits of his adaptability.

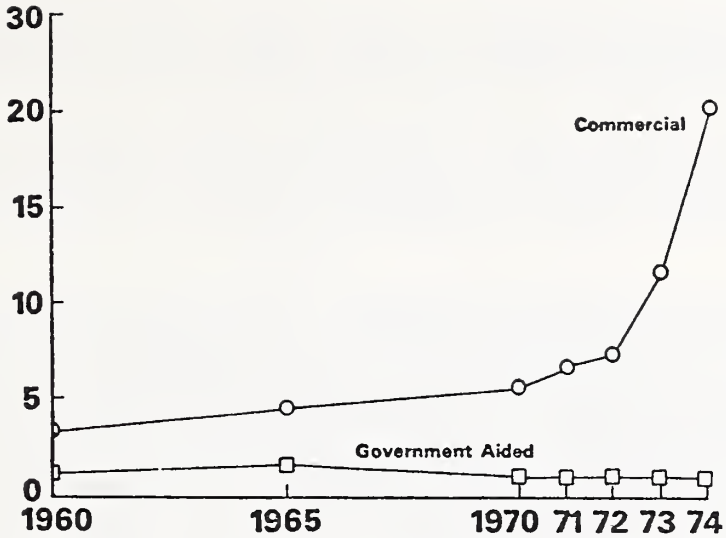

Figure 2.--United States agricultural exports 1960-74 (from *How U.S. Farm Exports Have Grown*, U.S. Department of Agriculture, Office of Communication, September 1974).

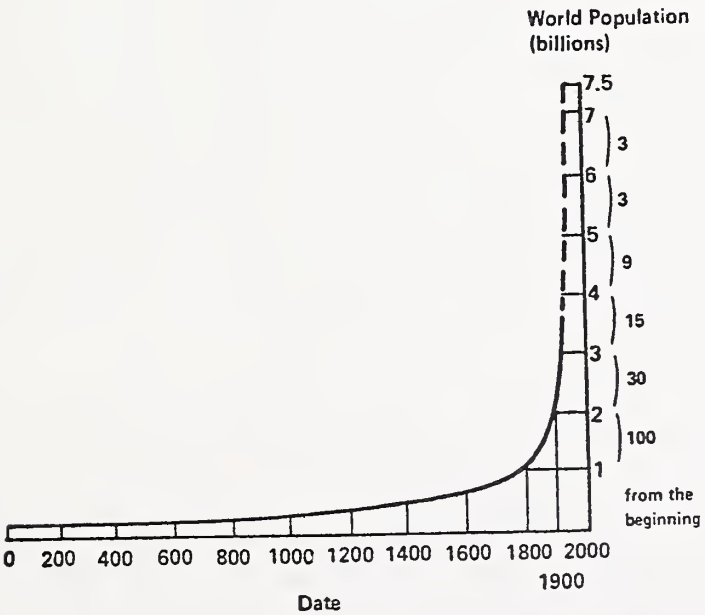

Figure 3.--World population growth, projected with assumption of constant fertility levels and declining mortality (from *World Population: A Challenge to the United Nations and Its System of Agencies*, UNS-USA National Policy Panel in World Population, May 1969).

A general solution is not in sight but we can at least visualize certain consequences of rapid population growth. I will briefly mention some that are particularly relevant to the present subject.

(1) The prospect of feeding the world adequately is hopeless, of course, if the present rate of population increase (about 2.2% per annum) continues. Obviously, exponential growth in numbers of people can not go on indefinitely.

It should be clearly understood, however, that population control measures can not solve the acute food problem that will develop in the decades just ahead. It would still take 75 years or so to obtain zero population growth if the net reproduction rate of unity were achieved today. This is because of the tremendous momentum for growth inherent in the young age distributions in many of the underdeveloped countries. In Mexico, for example, with its 60 million people, the growth rate is not only very high, namely 2.4%, but 48% of the present population is under 15 years of age. In Sweden, in contrast, where the growth rate is 0.2%, only 21% of the population is under 15 years of age. (World Population Estimates, 1975, prepared by The Envirnomental Fund, Washington, D. C.) Mexico's population will continue to surge even if size of new families is reduced at once to 2.1, the replacement value. Sweden's numbers, on the other hand, would quickly decline under the same family limitation.

(2) The United States and Canada are the only remaining nations in the world with large surpluses of grain. Various parts of the world that formerly were either self-sufficient or produced a surplus, are now net importers. Western Europe has long been a grain deficit area. Now Asia, Africa, and Latin America also are in that category. The United States in 1974 supplied 85% of the world's soybean exports, 60% of the feed grain exports, 45% of the wheat and 24% of the rice (U.S.D.A. Office of Communication data, 1974). Rising prosperity and improved diets in the industrialized nations, especially Japan, Europe and the U.S.S.R., have used up the surplus stocks accumulated after World War II and also have brought back into cultivation the idled cropland in the United States and Canada. The rising demand from the industrial nations means that there will be progressively less food available from the United States and Canada that might be used to feed poor countries. The inference is clear: the underdeveloped countries must look to themselves for the major portion of their additional food supply. Can they meet the demand, particularly in view of the fact that there will be about 900 million more people to feed within 10 years? Many with experience in the field are hopeful that food production can be greatly increased eventually in the underdeveloped countries, but not rapidly enough to meet the shortages likely to develop in the decades just ahead. Deep apprehension arises from the fact that increasing agricultural production in much of the Third World is not merely a technical problem; it goes to the political, social, and economic foundations of the nations involved. This brings me to the next main point.

(3) Raising food production on a scale commensurate with the surging populations of the underdeveloped countries necessitates changing from

subsistence farming to market agriculture. Needed by growers is the purchasing power to obtain fuel, fertilizer, irrigation water, seed of improved varieties, pesticides, tools, machinery, storage facilities, transportation, and also the management skills required for a complex farming and marketing operation. The switch from subsistence to commercial agriculture and the associated industrial developments involves no less than a reordering of the national economy in many instances and radical changes in patterns of living.

(4) If large food shortages become widespread the consequences are portentious not only for the Third World countries but for the industrialized nations also. Tensions between the rich and the poor countries will rapidly mount with respect to (a) the donation of food for the relief of starving people, (b) the terms of international trade in various natural products on which industry is dependent and (c) greatly increased monetary and technical assistance for Third World development.

Responses to the Crisis

We may now ask what our responses should be to the rapidly mounting world pressures for more food. Since no general international plan for coping with the population problem is now in sight, the several consequences of the explosive growth in human numbers will have to be dealt with separately as they become evident. Numerous crucial questions will arise including how to contain inflation in the face of persisting food scarcities. Attention here focuses on a far less conspicuous problem but one that is also vital for the long-term national welfare, namely, the protection of our soils from degradation as a result of the growing pressures on them. The present trend towards increased acreages of row crops must be balanced by measures that will conserve the soil. It is not my intention to outline the various measures required. Many specialists are already concerned with the agricultural research and development needed in a world swarming with people. (See, for example, Wittwer, S. H., 1975, Science 188:579-584, and Wade, N., Ibid, 585-589). My object has been to focus attention on the domestic problem that, in my judgment, should have the highest priority, namely protection of the soil against destruction. It is quite unnecessary for me, of course, to inform the members of the Alfalfa Conference of the vital role that forage crops play in dealing with this broad problem. Alfalfa, as a productive, nutritious perennial, is especially significant in soil erosion control, and an expanded research effort with it is needed. Breeders are aware, for example, that much laborious testing of diploid and tetraploid wild forms of Medicago falcata remains to be done before the heterotic and other less cryptic genetic values in this highly diverse species can be identified and systematically utilized in developing superior cultivated forms. New uses for alfalfa also are important. The recently published work of your president, Dr. M. W. Pederson, and 16 collaborators, on effects of selection for high and low saponin content is a significant step toward alfalfas whose products can be as safely employed in rations for swine and poultry as for ruminant livestock.

An immediate question is how to gain the financial support needed for the greatly expanded volume of work on forage crops that should be done. H. J. Hodgson in the February, 1976, issue of Scientific American states that, whereas grasses and legumes fed to livestock are the mainstay of United States agriculture, this class of crop plants now receives only about 4% of the funds provided for agricultural research. Relative to current needs this, indeed, is a gross imbalance in support.

During the last 30 years great gains have been made in controlling soil erosion on the United States cropland most subject to such losses. Millions of acres less prone to damage, but vulnerable over time, still await corresponding protection. The national goal for soil conservation should now be soil security for all sloping cropland. Wider application of all the familiar devices, contour farming, strip cropping, terraces, advanced tillage practices, interplanting, and the like, is needed so that we can safely use more cropland intensively.

One may venture the opinion that the U.S. acreages of corn and soybeans, which are already so large that they extend on to much unprotected sloping land, will rise further. Strong market forces, the vitality of the whole corn enterprise from breeding to feeding, and the unique position of soybeans as a protein source may continue to drive the acreages of these crops upward. Increasing interest in the production of soybeans in Brazil and of palm oil in the Tropics, however, may make soybeans a less attractive crop to United States farmers.

Cost sharing, using public funds, is already a well established procedure to encourage farmers to adopt soil conservation measures in their own interest and those of posterity. This economic incentive is essential to the success of any voluntary soil conservation program involving outlays substantially beyond ordinary farm costs. Much land in need of soil saving measures remains outside organized programs because the public funds available for cost sharing are inadequate to attract the owners.

Shades of the 1930's

The House of Representatives in Washington, D. C., passed a bill in May, 1976, that would establish a Young Adult Conservation Corps to assist in flood control, forestry, and the like, on public lands. Should the Senate concur in, and the President approve the measure, 1.2 million jobs would be provided for persons 19 to 24. It should be recalled in this connection that soil erosion control was given great impetus during the serious economic depression 40 years ago by the formation in 1933 of the Civilian Conservation Corps (CCC). The initial proposal put before Congress at that time would have limited the CCC work relief program to publicly owned forests and parks. At the urging of Noble Clark, Aldo Leopold, C. L. Christensen, E. R. Jones, and O. R. Zeasman of the Wisconsin College of Agriculture, Senator Robert M. LaFollette, Jr., introduced and secured passage of an amendment to the unemployment relief bill whereby CCC camps could be established for soil erosion control also on private land where the owners

would defray a reasonable portion of the cost. The resulting CCC rural programs were outstandingly successful. The national interest would be well served if provision were made in the Young Adult Conservation Corps proposal now before Congress for employment of the enrollees on privately owned farms as well as on public lands.

The Need for Public Education

A crucial element in determining the course we shall follow in the years just ahead is the attitude of taxpayers. In our predominantly urban society it may be difficult to gain the public support needed for funding an adequate soil conservation program. Public opinion will shift, however, with a progressive worsening of the world food crisis, and as famine abroad becomes more commonplace. The first priority is putting our own house in order. We have the means and the necessary lead time to cope with our domestic problems and also to aid others to help themselves with theirs. Many Americans still think in terms of abundance and steadily rising expectations. But shortages of various kinds, including energy, are now raising prices and pushing inflation. Recognition of the need for conservation in general will grow, and with it appreciation of the public's dependence on the soil for food.

The practical objectives that I have emphasized can be attained by more broadly implementing already familiar conservation methods. The immediate problem is to overcome the delay in applying on a large scale what is already known. A principal reason for the delay involves a general issue that should be mentioned. It is that man, as a species, has yet to be convinced of his true place in nature. If he understood his position in the natural hierachy he would have accepted what Aldo Leopold has termed a "land ethic", whereby his attitude toward the soil as a key component in the life support complex would have been realistically shaped. Leopold has stated that "We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect. There is no other way for land to survive the impact of mechanized man ....." (Leopold, Aldo, 1966, A Sand County Almanac, New York, Oxford University Press).

René Dubos, the distinguished biologist and environmentalist, points out that man has evolved over a long period as a part of the natural world and that he can not escape the consequences of his genetic heredity. Vainly he tries to set himself above nature, tending to deny that he is an integral part of it (Dubos, René, 1968, So Human An Animal, New York, Chas. Scribner's Sons). The land ethic demands a harmonious balance between nature and all the works of man. Systematic cultivation in the public mind, in this critical period, of an ethical sense of man's relationship to the soil would facilitate the conservation of cropland which has now become more vulnerable to destruction than ever before.

Alfalfa Weevil Research: Crop, Insect, and Management Modeling

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Our component of the NSF/EPA Integrated Pest Management Project has concentrated on the alfalfa, alfalfa weevil, alfalfa weevil parasite (*Bathyplectes curculionis*) system. The modeling effort has been supported by field studies of alfalfa production and insect population dynamics. Models have been developed for the crop, insect, and management aspects of the system.

The alfalfa production model, called ALSIM 1 (1), uses initial conditions of the crop, cutting dates, and solar radiation and air temperature data to predict yields of hay and growth curves for leaves, stems, basal buds, and total nonstructural carbohydrates of the taproots. Many of the physiological functions used to develop growth predictions were taken from the more sophisticated SIMED model (2). The alfalfa insect model was developed by Ruesink at Illinois (3). It requires initial adult insect populations and temperature data, and it predicts the population dynamics of the weevil and the parasite, including parasitized weevils. The alfalfa and the insect models have been combined to simulate the crop-insect interactions.

To determine the most economical management strategy, Shoemaker (4) has developed an optimization procedure using the crop and insect models. For given weather patterns and insect populations, the management model will select the cutting dates and spray programs that maximize economic returns. The planning horizon for management strategy can also include several years. If the model assumptions are correct, early harvesting (June 2 to June 7) is reasonably effective in keeping the weevil population in check, and insecticide treatments are usually needed only at combinations of low parasite populations and above average weevil numbers.

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The Potato Leafhopper and Alfalfa Quality

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The potato leafhopper, Empoasca fabae (Harris), is one of the most destructive insects attacking alfalfa in the Eastern United States. There are 2.4 million acres of alfalfa grown in the Northeast of which about 1.0 million are attacked by the potato leafhopper every year. Insecticide sprays are the only control method for the potato leafhopper and are effective only if applied before potato leafhopper nymphs reach high enough numbers to turn alfalfa yellow. Once yellowing occurs, the alfalfa plants will not recover even if potato leafhoppers are controlled. Consequently, proper timing is essential to successful control by insecticides. The decision to spray is based on sweep-net collections which estimate the population density of the leafhopper. Current recommendations are to spray when leafhoppers reach 1 per sweep and this recommendation was developed by Poos (1942) and is still in use by many states today. However, sweep-net collections have not been accepted by many growers because of the difficulty in recognizing and counting the insect. Therefore, many growers fail to determine the proper time to spray. Furthermore, many entomologists speculate that the 1 leafhopper per sweep is too high an estimate to base control recommendations on modern day forage alfalfa. Our objective was to correlate potato leafhopper densities with hay yield and quality and also measure the effect of potato leafhopper feeding on plant survival.

Four fields of spring-seeded alfalfa were selected for treatment in 1974 and 7 fields in 1975. Each field had 2 treatments following 1st harvest: methoxychlor at 0.75 lb ai/acre (1974) or dimethoate 0.33 lb ai/are (1975) and an untreated strip along 1 edge of the field of about 2 acres. Weekly sweep-net collections were made in each field with estimates of yield and samples for quality at 2nd and 3rd harvest. Plant stand counts were made before treatment and in the fall of each harvest year.

There were significant increases of 0.3 tons dry matter and 4.3% more protein in treated areas in 1974 with similar results in 1975. Protein was negatively correlated with potato leafhopper early and late instar nymphs 2 weeks before harvest and adults 1 and 2 weeks before harvest. In vitro dry matter disappearance (IVDMD) was negatively correlated with early instar nymphs 2 weeks before harvest, late instar nymphs 1 and 2 weeks before harvest and adults 2 weeks before harvest.

Yields in 1975 were 0.3 ton/acre higher in treated new fields and 0.6 tons higher in treated old fields. Treated portions of fields had an average of 2 more plants per foot of row than untreated portions. The number of leafhoppers per sweep above which damage occurs was about 0.5.

Poos, F. W. 1942. The potato leafhopper, a pest of alfalfa in the Eastern United States. USDA Leaflet 229, 8 p.

Selecting Alfalfa Resistant to the Potato Leafhopper

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Screening for resistance to insects in alfalfa at the Kansas Exp. Sta. includes the search for resistance to the pea aphid, the spotted alfalfa aphid, the potato leafhopper and the alfalfa weevil. Cooperative efforts of plant breeder (E. L. Sorensen), and plant pathologist (D. L. Stuteville) are directed to incorporate resistance also to diseases (bacterial wilt, downy mildew, phytophthora and anthracnose) into our advanced selections. Selecting for leafhopper resistance has been done primarily in the field although techniques for screening of seedlings have been developed (1). Two cycles of recurrent phenotypic seedling selection in growth chambers increased resistance to leafhopper yellowing in the field (2). Although seedling screening may accelerate selection, plants still must be evaluated in the field to avoid undesirable shifts in other characters. The feasibility of using excised plant parts to test clonal preference by the potato leafhopper in field and greenhouse grown plants was studied in a controlled environment (3). Field ratings for yellowing and laboratory ratings for yellowing and wilting correlated significantly. Leafhopper yellowing in the field and nymphs/gram of dry plant material did not correlate. Clonal preferences were displayed in both the field and laboratory, but the ratings did not correlate. Excised plant parts from the field provided a more reliable assessment of resistance than did those from plants growing in the greenhouse. Clonal yellowing and wilting of excised terminals from field grown plants were correlated highly ($r=0.91^{**}$) with yellowing in the field. Excised stem terminals from plants grown in a greenhouse were less resistant to both adult and nymphal leafhopper feeding than were terminals from plants grown in the field. Efforts continue to explain the role of chemical and mechanical resistance factors, e.g., saponins, pubescence (4, 5). Deliberate efforts are directed toward protecting alfalfa from genetic vulnerability by practicing wide-crossing through recruiting of parents from geographically distant gene pools and by inter-species hybridization (e.g., *Medicago sativa* x *M. falcata*).

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Effectiveness of Parasites of Alfalfa Blotch Leafminer

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The alfalfa blotch leafminer, Agromyza frontella (Rondani), is occasionally an economic pest of alfalfa. The leafminer, abbreviated ABL, is a European species, first observed in the USA in Hampshire County, Mass., in 1968. Since then it has spread throughout the New England states north into the Canadian provinces of New Brunswick, Quebec, and Ontario, west to the Ohio-Pennsylvania border and south into Delaware and Maryland. Summaries of information about ABL, especially useful for identification, can be found in Spencer (1) and Steyskal (2).

The author studied ABL in the Delaware, south-central Pennsylvania, and southern New Jersey areas in 1975-76 where the fly had 5+ generations per year. The first 2 generations were discrete, each lasting about 5 weeks, thereafter, generations overlapped. The second generation, which appeared between the first and second cutting of efficiently farmed alfalfa, was the most severe. The principal damage of ABL was that most mined leaflets shattered 1-2 weeks after the mining larvae dropped from the mine to pupate in the soil. Heavy rain appeared to accelerate shattering.

Parasitism of the first generation at its peak of larval population was 10%, 2nd generation 5%, and later generations 50%. Native parasites appeared overwhelmed by the sudden abundance of ABL larvae in the 1st and 2nd generations. Native parasites of ABL probably came from Liriomyza spp. on alfalfa. Liriomyza larvae first appeared in the field about 5 weeks after ABL larvae, so that parasites adapted to Liriomyza spp. were poorly synchronized with ABL. Fourteen species of native parasites were collected in 1975. Almost 100% of the individuals were larval parasites.

In Europe, ABL is under excellent biological control. They have perhaps as many as 5 species of pupal parasites, where we have no effective pupal parasites. Unfortunately, rearing methods for pupal parasites have not been developed and releases of small numbers of these pupal parasite species have resulted in no recoveries. The European eulophid, Diglyphus isaea, a larval parasite was reared and about 36,000 released through June of this year. Although recoveries have been made, the species crosses one way with a native Diglyphus sp. making establishment at best uncertain. Biological control appears hopeful if European pupal parasites can be established.

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Biology and Management of the Alfalfa Blotch Leafminer

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Distribution of Agromyza frontella, the alfalfa blotch leafminer, has been expanding at the rate of ca. 50 miles per year in the Northeastern United States. It is now found in all areas of the Northeast including Pennsylvania and Maryland. In central New York it overwinters in the puparium, emerging in early May as an adult. Three to three and one-half generations corresponding quite closely to three cut alfalfa management are common in this area. The second generation occurs in July, attains the highest densities and economically appears to be the most important. Harvesting in the first cutting just prior to the peak of the blotch stage miner will significantly reduce densities in the second generation. All larval stages are very susceptible to most insecticides used for alfalfa weevil control, except methoxychlor. Typically areas of new infestation reach very high densities in about two to three years and then level off at lower densities after about five years.

Preliminary Evaluation of Alfalfa for Resistance to the Alfalfa Blotch Leafminer

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A space-planted nursery of 6550 seedlings was established in late April 1972 at Valatie (upper Hudson Valley), a location with the first heavy infestation of the alfalfa blotch leafminer in New York. Fifty-six germplasm lots, many originating from plant introductions chosen on a world-wide basis, were included along with domestic lots. About half of the nursery consisted of seedlings from the ARS, USDA germplasms which carried multiple pest resistance: 'Team', MSA CW3 An3, MSB CW5 An3, MSHp6F An4 W4 and MSHp6FOV. No resistance was evident to entomologists and geneticists who visited the nursery in 1972 and 1973.

However, I selected 27 clones after taking notes on the second and third growth in 1973. These were interpollinated with honey bees during the winter and a new nursery was established in 1974. This nursery of 7700 seedlings was established from the 27 polycross progenies from clones selected in 1973 and 73 other germplasm lots including those originating from introductions. Notes have been taken on the second crop in 1976. Only thirty-eight plants have been selected and it is probable that some of these will be discarded if a suitable infestation occurs in the third crop.

The clones selected in 1972 came from 17 of the 56 different sources. No single source was noteworthy. It seemed probable that those selected were "escapes".

The clones selected thus far in 1976 have the following origin: 23 plants from 14 of the 27 polycross progenies and 15 from 11 of the 73 germplasm lots. The rate of selection from the polycross progenies of clones selected in 1974 is 5.7% and from the unselected germplasm lots is 4.1%. Again no single source was noteworthy as a source of resistant plants.

It seems doubtful that a significant level of resistance exists in this germplasm and, therefore, that selection has been effective.

Selection in a field nursery with natural infestation is complicated by two factors; one, depradation by the alfalfa weevil in the first crop and two, variable infestation throughout the nursery and on plants of differing growth habit and/or maturity. However, the uniformity of natural infestations of the alfalfa blotch leafminer seems to be greater than for the alfalfa weevil.

I believe that testing for reaction to the alfalfa blotch leafminer should be done under conditions in the laboratory or field where the effects of other deleterious insects are controlled or eliminated and infestations are as uniform as possible. Related species of Medicago should be evaluated for resistance.

Progress in Developing Alfalfa Germplasm with Resistance To the Blue Alfalfa Aphid, *Acyrthosiphon kondoi* Shinji

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The blue alfalfa aphid (BAA), which closely resembles the pea aphid, was found in damaging numbers on alfalfa in Imperial County, California, in the spring of 1975 and identified as a new pest of alfalfa. Subsequently, insect collections made in Kern County, California, during the summer of 1974 were reexamined and specimens of the BAA were identified. The BAA has since been found in all major producing areas in California as well as in Nevada, Utah, Arizona, New Mexico, Kansas, and Mexico.

Plants heavily infested by BAA are stunted, have short internodes, and small, crinkled, yellowing leaves. Young, succulent, terminal growth seems to be preferred. In addition to the typical damage, affected fields have a ragged, uneven appearance indicating some of the better appearing plants may have a level of resistance to this insect.

Reaction of alfalfa cultivars to the BAA was obtained during a period of severe infestation. All cultivars tested were rated as susceptible to very susceptible. However, small differences in cultivar reaction were detected with Niagara N 71 Brand, El Camino Brand WL 508, UC Salton, and UC Cargo being less susceptible than Mesa Sirsa, Hayden, and Sonora. Eastern cultivars such as Arc, Saranac, Weevlchek, Team, and Gladiator were highly susceptible. Kanza appeared slightly better.

Alfalfa plants appearing resistant to the BAA were selected from a severely damaged field in the spring of 1975 and combined into two synthetics called CUF 101 and UC 102. Selection criteria were aphid number, plant color, leaf shape, general appearance, and height. In seedling tests conducted at Tucson, Arizona, the CUF 101 and UC 102 had 52.7 and 15 to 45 percent survival, respectively. Survival of check cultivars such as UC Cargo, El Unico, Mesa Sirsa, and Washoe was 0 to 1.3 percent. On the basis of these selections and tests it appears alfalfa germplasm with good resistance to the BAA can be developed. In addition, since other cultivars observed seemed variable in reaction to the BAA, it seems resistant plants can be selected from them also.

Limited observations and experience indicate the screening methods used for other aphids on alfalfa should also be useable in screening for the BAA. Effective greenhouse flat screening tests were conducted by using 3 to 8 applications of 4 to 8 cc of BAA per flat when the plants were in the unifoliate stage. Other workers have reported this treatment was very severe in their tests. Specific experience on other methods is limited. BAA has been cultured on alfalfa plants with variable results.

Alfalfa as a Protein Source for Nonruminant Animals

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Alfalfa produces more protein per hectare than any other common crop, and the protein has a satisfactory amino acid balance. Swine and poultry are not at present fed high dietary levels of alfalfa. The problems with its use include the fiber content (hence low digestible energy), the presence of toxins (saponins, tannins), the low digestibility of the protein, and low palatability. Efforts to improve the value of alfalfa meal as a protein source necessitate determination of the relative significance of the above factors, and how they might be modified. Alfalfa saponin is bitter, contributing to the low palatability. Saponin might also affect the availability of the protein. Tannins and other phenolic compounds in alfalfa may react with protein and reduce its availability. Protein "tie-up" through reactions with components of the fiber fraction may also be involved.

Processing method may influence the acceptability of alfalfa to animals. Nebraska research has indicated that freeze-dried alfalfa gives better feed efficiency with baby pigs than heat-dried material. At Oregon State, freeze-dried alfalfa has given increased growth and feed efficiency as compared to air-dried or oven-dried alfalfa for rats (2). The effect of freeze-dried alfalfa is mainly due to greater palatability; the nature of changes associated with normal drying that cause reductions in palatability remain to be determined.

Rather than using alfalfa meal directly, another approach is to extract the protein to produce an alfalfa protein concentrate (APC). Studies with APC have indicated that it is approximately equivalent to soybean meal as a protein source for swine and rats (1, 2). When prepared and dried without heat damage, APC has methionine as the first limiting amino acid. APC is palatable to swine, and in the Oregon work has given results similar to those obtained with soybean meal. In New Zealand studies, skin lesions due to photosensitization reactions resulting from chlorophyll in APC have been observed.

Use of alfalfa meal as a protein source for nonruminant animals appears less promising than the APC. At high dietary levels, alfalfa meal is not palatable to swine, probably due to both physical characteristics of the fiber, and to saponins, tannins, and probably other bitter components. The protein is of low digestibility. The protein concentrate is of high palatability, the protein is of high digestibility, and the % protein of the APC (40-50%) is comparable to other available protein supplements. Development of an APC industry will ultimately be determined by the economic variables; swine feeding trials indicate that the product could be successfully substituted for soybean meal in swine diets.

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The Chemical Basis for Breeding a Non-Bloating Alfalfa Cultivar

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Several approaches to the development of a non-bloating alfalfa cultivar have been suggested: These include selection for: (1) low leaf-stem ratio, (2) low foam volume, (3) low saponin concentration, (4) low fraction I protein (18S protein) concentration, or (5) low total soluble protein concentration. Since 1972, one objective of the alfalfa program at this research station has been to evaluate these alternatives and to select the best one for use in breeding a non-bloating alfalfa cultivar. This report describes our progress toward this objective.

Selection for low leaf stem ratio would probably lower the bloat potential of alfalfa but it would also reduce the nutritive value of the crop. This is an important disadvantage, especially for dairy cattle. For this reason we have not given serious consideration to changes in leaf stem ratio.

A head of foam is generated when fresh herbage is blended with aqueous buffer solution in a "Waring" blender. The volume of foam can be measured reproducibly and the heritability of this parameter was reported as 0.73. Selection for low foam volume has been proposed as method of breeding a non-bloating alfalfa cultivar, but in a 3-year bloat incidence trial we have not obtained any significant relationship between bloat incidence and the foam volume generated from daily feed samples.

Saponins have been implicated as causative agents in pasture bloat for a number of years and with the availability of high and low saponin strains it is now possible to obtain further information by determining bloat incidence on the selected strains. No data have been reported to date. It is our opinion that saponins may contribute to the frothy condition in pasture bloat but the importance of their contribution is less than the plant proteins.

The proposal that fraction I (18S) protein is the primary causative agent in pasture bloat has been criticized in recent years. We believe that selection for low fraction I protein concentration is not a suitable approach to the objective.

We have recently completed a 3-year feeding trial to determine the relationships between bloat incidence in cattle fed alfalfa and the concentrations of selected nitrogen and protein fractions in fresh herbage. The closest relationships with bloat incidence were obtained with soluble nitrogen and soluble protein nitrogen. These are the best parameters available at the present time for identification of bloat-causing genotypes but they do not account for all the variation in bloat incidence. Development of a non-bloating alfalfa cultivar by selection for low soluble protein concentration might be accomplished by variation in cell rupture, by introduction of tannins into alfalfa or by changes in amino acid composition of the soluble proteins.

Developments in Evaluation of Forage Quality by Infrared Spectroscopy

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Infrared reflectance spectroscopy has been proposed as a rapid and accurate method of predicting forage quality. This instrumentation can be used to predict the concentration of multiple forage parameters with less than 5 g of ground sample in less than 2 min. The procedure does not require moisture determination or simple weighing before or after analysis.

We have established an infrared reflectance spectro/computer system (IRSCS) at the U.S. Regional Pasture Research Laboratory in cooperation with The Pennsylvania State University to study the basic and applied aspects of this technology. Temperate forage species studied include alfalfa, crownvetch, bromegrass, tall fescue and orchardgrass. Forage samples of mixed species and forage-concentrate mixtures have also been evaluated. Calibration equations have been developed to predict laboratory analysis and large animal performance of forage.

Using our present system of data collection and processing and 5-8 wavelengths for each parameter, standard errors of calibration for 62 forages (35 alfalfa, 14 fescue, 13 bromegrass) were: ±0.61% for crude protein (CP), ±1.93% for neutral detergent fiber (NDF), ±1.36% for acid detergent fiber (ADF), ±0.97%% for cellulose, ±1.02% for hemicellulose, ±0.85% for lignin, ±0.65% for ash, ±1.52% for *in vitro* dry matter disappearance (IVDMD), ±2.30% for sheep digestibility, ±6.95 g/day/Wt in kg to the .75th power for sheep intake and ±6.50 g/day/Wt in kg to the .75th power for sheep digestible dry matter intake. Standard errors of duplication or repeated values from the same sample were ±0.46% for CP, and ±0.75% for IVDMD. Standard errors of predicting CP and IVDMD for 30 orchardgrass and 50 alfalfa samples not used in the calibration were ±1.00% for CP, and ±1.70% for IVDMD.

Other parameters that show promise for prediction include sheep preference and β-nitropropionic acid concentration of crownvetch, nonstructural carbohydrates in grasses, $/ton, and intake and milk production of dairy cows.

Commercial instruments are currently being marketed that have the capability of predicting CP, ADF, NDF, and possibly IVDMD. Standard errors of predicting these chemical constituents may be somewhat greater than those reported for our IRSCS. These instruments have limited numbers of wavelengths and capacity for data processing. Nevertheless, commercial instruments may be useful for many applications where these standard errors are acceptable to the user.

A Seasonal Influence on Alfalfa Quality

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Quality in perennial forages appears to be influenced by two cycles. The first cycle is the well recognized crop sequence in which quality decreases rapidly with maturity. This cycle is repeated with each crop during a season. The other cycle is a season long period in which quality decreases during the heat of midsummer and is high during spring and fall.

The decrease in quality in the crop cycle is caused by an increase in fiber and a decrease in protein concentration. The reason for the reduction in quality during midsummer (seasonal cycle) is not known with certainty. However, in alfalfa saponin concentration increases during this period, and alkaloids in certain grasses have a similar pattern.

In alfalfa, saponin is much more concentrated in parts of the roots than in the foliage and can be translocated from roots to stems as demonstrated by root grafts and bleeding experiments. The perennial nature of the roots and their translocation capability permit a rational explanation of the seasonal cycle.

Effect of Harvest Managements and Cultivars on Yield and Quality of Alfalfa Forage in New York.

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Nine alfalfa cultivars, including all growth types adapted to the Northeastern U.S. were harvested according to three intensive cutting schedules for two years at three locations. Cutting schedules (managements) included one 4-harvest system with initial cut on June 1 and subsequent cuts after 5, 6, and 7 week intervals, and two 3-harvest systems: one with initial cut on June 8 and subsequent cuts after 6 and 7 weeks, and the other with initial harvest on June 18 and subsequent cuts after 6 and 7 weeks. Dry matter yield, % crude protein (CP), %IVD, and % leaves were determined for each cultivar at each harvest.

Significant differences in the yields of the different growth types were evident when yields were averaged over managements, locations, and years. No cultivar by management interaction was observed.

In 1974, the first full production year, there was no significant difference in the average total season yields of the three managements. However, in 1975 the yield of the 4-harvest system decreased by 20% while the yield of the two 3-harvest systems increased by approximately 6% over 1974.

In 1974, cultivars differed significantly in % IVD, % CP, and % leaves as averaged over all harvests. The magnitude of the inter-cultivar variation for these characteristics was small relative to the variation in dry matter yield. Season yield of DDM, CP, and leaves was therefore closely related to the total dry matter yield.

Although not different than the 3-harvest system in dry matter yield, the 4-harvest system yielded significantly greater quantities of DDM, CP, and leaves. The substantial decrease in yield of the 4-harvest system in 1975 is expected to outweigh any advantages this system might have in the form of higher average % IVD, % crude protein, and % leaves.

Alfalfa Management for Maximum Returns in Michigan

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Research results since 1950 in Michigan have been at least partly responsible for the increase of alfalfa yields from 2.3 tons/acre in 1950 to 2.8 tons in 1975. These state yields are low compared to research yields reported since 1950 at this experiment station since many are based on old stands, are harvested only once per year, and do not reflect yields possible with known technology. Good dairymen document (Telefarm records) average yields of 4 to 4½ tons hay per year; reports of 6 to 7 tons hay are not infrequent.

Over 9 tons hay/acre have been obtained in a 2-year trial at East Lansing. A 6-year trial produced an annual acre yield of 8 tons. The research leading to these high yields started in 1950 with improvement in stands by band seeding which was reflected in more vigorous and reliable stands in the state. Research yields were in the 3½- to 4-ton level during this period.

Research in 1956-57 showed alfalfa increased from 4.1 to 5.1 tons with 525 lbs. K_2O/acre with the first of 3 cuts in mid-June (too late). Yields were increased to 6.1 tons for a 2-year period in 1959-60 by taking three cuts (June 1-Sept.1) instead of two and using 400 lbs. K_2O/acre.

DuPuits was 10% higher in yield than Vernal in a 1963-64 experiment (5.4 to 6.1 tons), indicating a medium-hardy variety was hardy enough for Michigan. By changing varieties (Vernal to DuPuits), applying P and K(0+50+200), and increasing cutting frequency (3 instead of 2 cuts), yields increased 56% (3.01 to 4.72) but feeding value per acre increased 92%. Saranac, a wilt-resistant, moderately-hardy variety, was 7% higher in yield than DuPuits for a 3-year period between 1970-72 (7.8 vs. 7.3 tons); for a 6-year period (70-75), it was 43% higher yielding (7.0 vs. 4.6 tons). 520, a proprietary variety, was 5% higher yielding than Saranac (8.3 vs. 7.8 tons) in a 3-year period.

Between 1969-72, four cuttings (June 3-Oct. 15) yielded 13% more (6.9 vs. 6.1 tons) than 3 cuttings. Stands persisted well into 1976, the seventh year. Fall cutting results between 1964-75 showed that the third cutting of alfalfa can be taken anytime after Sept. 1 with no yield reduction or stand depletion when compared to a Sept. 1 cutting. This makes green chopping or Sept. cutting possible.

The maximum 2-year average annual yield of 9.14 tons/acre (9.47 in 1975) was obtained in 74-75 on a well-tiled, Brookston Class I loam with high water-holding capacity. A 6-year average of 8 tons (7.93) per year was obtained with one variety (520) on a similar soil. Spraying for alfalfa weevil control started in 1969 and probably contributed to lower leafhopper populations and greater yields than in earlier experiments. Resistance to Anthracnose in 1975 increased yields from 7.77 to 7.98 tons/acre.

Yields of 4.7 tons were obtained in the seeding year by cutting herbicide-treated Saranac alfalfa seeded April 10. The practice is used on about 10% of new seedings. Twelve pounds yielded more than 8 in a 7-year trial.

Yields of over 10 tons per acre for a 2- to 3-year period will be obtained in the future at East Lansing, without irrigation, with higher K (possibly B and S), seed rates of 16 lb/A, four cuttings/yr., Anthracnose- and Phytopthora-resistant varieties, and the most vigorous varieties such as Americana or T4X201 (if moderately hardy). Resistance to a host of debilitating diseases would likely improve yields.

Alfalfa Management for Maximum Returns in Eastern Canada

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Renewed interest in forages is prevalent throughout Eastern Canada. Increased costs for grains and protein for the basic livestock economy have been largely responsible. Forage seed supplies were nearly exhausted in 1976 for seeding a part of the ten million forage acres which cover over half of the cultivated land. Alfalfa is the principle legume seeded on much of the area, especially in Ontario.

Spring seedings of alfalfa at about 12 lb per acre have been shown to be superior for top yields. Summer seedings frequently do not survive the first winter well. Forage seedings are made with a grain companion crop and are slowly giving way to the estimated 15% direct seeded meadows.

All meadows are harvested early, primarily for hay, with a gradual swing to silage systems. Top dairymen are striving for +20% crude protein packages which means early harvesting of pure alfalfa, stored generally as wilted silage. The use of preservatives in the silage making process is practised by few.

Persistence in alfalfa reigns as the largest single problem associated with the crop. Low winter temperatures, variable snow cover and icing conditions are the principle contributors to the winterkill problem. Fall top growth accumulation has proven to be important. It holds the snow and keeps the crown temperature higher, aids in the prevention of ice accumulation on the soil surface and subsequently provides for higher yields in the succeeding year.

Grass associations with alfalfa, which are thought to provide more insulation, have not increased alfalfa persistence. Killing has been associated with the top inch or so of the wintering root. Insulating the alfalfa crown with an additional inch or so of soil has been shown to provide top persistence under even severe winter pressures. This and other studies are indicating that a low crown alfalfa might be a substantial step toward better alfalfa persistence in Eastern Canada.

Alfalfa Management for Maximum Returns in Southeastern United States

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Alfalfa (Medicago sativa L.) properly managed will produce about 10,000 kg/ha of dry forage annually and persist for four years on many soils of the upper South. Liming and supplemental fertilization is essential. Most soils that have not been limed previously will require 3300 to 5600 kg/ha of dolomitic limestone prior to seeding in addition to phosphate, potash and boron. On the average, 26 kg/ha of P, 150 kg/ha of K, and 2 kg/ha of B is required annually.

Middle to late summer seeding is preferred to spring seeding, and a seeding rate of 20 to 25 kg/ha is recommended. The newer varieties which have anthracnose (Colletotrichum trifolii) resistance and alfalfa weevil (Hypera postica) tolerance will yield better and persist longer than older varieties not having these characteristics. Seed should be broadcast or drilled into a well prepared seedbed and lightly covered, but not more than one centimeter deep. Pure alfalfa rather than a mixture of alfalfa and grass should be seeded when a herbicide is to be applied for the control of weeds.

Inadequate techniques in applying rhizobia have often resulted in poor inoculation and poor stands of alfalfa. Farmers have widely used both the "dry" and the "wet" methods of application. In several experiments the Pelinoc method of inoculation, which employs a high rate of inoculum (12 times the manufacturer's standard recommendation) and a wetting and sticking agent has been superior to other methods. On the other hand, alfalfa seed pre-inoculated with rhizobia and the dry application of inoculum at the time of seeding have given unsatisfactory results.

The chemicals EPTC (Eptam) and Vernolate (Vernam) have been effective as preplant herbicides for the control of most broadleaf and grass weeds, and they cause only minor injury to alfalfa over a wide range of rates and climatic conditions. The elimination of weeds increases the chances of obtaining a good stand of alfalfa and also reduces damage to alfalfa by the alfalfa weevil. Apparently, weeds provide cover for the weevil and henbit (Lamium amplexicaule L.) serves as a receptacle for egg laying by the weevil.

In most of the South exclusive of the Appalachian Mountains, fall growth can be removed as forage after the first killing frost with no loss of stand resulting. The removal of fall growth reduces spring weevil damage.

Recent experimentation indicates that the weevil tolerant variety, Arc, can be cut sooner in the spring and at a more immature stage than other varieties without a subsequent loss of stand. Cutting at the early bud stage rather than at the 1/10th bloom stage produces higher quality forage and increases flexibility in management by extending the first harvest period by two weeks. While one can safely cut Arc at the early bud stage in the spring, repeated early cutting throughout the season weakens the plants.

The insecticide carbofuran (Furadan) provides almost perfect seasonal control of the alfalfa weevil with a single spring application of a foliar spray. The insecticide should be applied after larval hatch, but before much larval feeding damage had occurred. The amount of insecticide used can be reduced when weevil tolerant varieties are grown.

Evidence for Seasonal Genetic Shift in Alfalfa Seed Production

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It is known that genetic shifts can occur when seed of an alfalfa variety is produced outside its area of adaptation. Characteristics such as plant height and winter hardiness have been altered significantly by producing seed at extreme latitudes in the United States. However, forage yields seldom have been changed significantly.

In 1971, a Virginia experimental alfalfa line, D-69, was thinly seeded in rows for seed increase at the Eastern Virginia Research Station, Warsaw, Virginia. The following year two seed harvests were obtained from the field; one in early August (D-69Wa) and the other in early November (D-69Wb). In the spring of 1973, both seed lots were planted in broadcast plots at Warsaw and Blacksburg, Virginia. Yields and other data were obtained during 1974 and 1975. Following is a summary of the Warsaw yield data.

	Tons/acre of 12% moisture hay			
Entry	5-13-74	6-18-74	7-18-74	8-28-74
D-69Wa	2.73*	2.04	1.27	1.32
D-69Wb	2.54	2.07	1.29	1.35
	5-27-75	7-3-75	8-12-75	9-11-75
D-69Wa	2.03	2.19	1.48	.85
D-69Wb	1.81	2.18	1.48	.87
	2-year averages			
D-69Wa	2.38*	2.12	1.38	1.08
D-69Wb	2.18	2.12	1.39	1.11

*Entries are significantly different at the 5% level of probability

The Blacksburg data showed a similar trend, but there were no significant differences. Stands were good at both locations. Anthracnose data from the field plots and greenhouse screenings failed to show any differences between the entries.

From these data it is apparent that a genetic shift has been caused by the season of the year in which the seed was produced. Since yield differences are evident only at the first harvest, and the early seed crop has the highest forage yield, it appears that the plants which had high early season vigor produced a larger portion of the early seed crop than of the late crop. This could be due large to photoperiod and temperature differences between spring and late summer. Contamination from a foreign pollen source is unlikely since the only alfalfa in the vicinity was a variety test nearly a half mile away. The similarity of yields at the second through fourth harvests is an indicator that the lots were very similar except for early season yield.

It is often assumed that genetic shift will not occur as long as alfalfa seed is produced in the area of adaptation. While this is probably true in general, these data provide evidence that seasonal changes at a given location can cause significant genetic shifts. Alfalfa breeders might need to keep this in mind when comparing data obtained from experimental seed lots produced in different seasons of the same year or possibly in different years.

Inheritance of a Black Seed Character and Its Use in Alfalfa Improvement

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The discovery of cytoplasmic male sterility in alfalfa has not completely solved the dilemma of hybrid alfalfa. Pollen dispersal in alfalfa is by insect pollinators. Pollinator effectiveness is dependent upon proximity of pollenizer and male sterile (MS) lines as well as the relative attractiveness of the lines to the pollinators. The present method of producing hybrid alfalfa seed is to plant the MS and the pollenizer lines in alternate 4-row blocks with a blank row between the blocks. Reduced seed production on the male sterile lines results because of proximity of the two lines, differential pollinator preference and because less than one-half of the field produces hybrid seed. The resultant increased cost of hybrid seed cannot be justified on the basis of the increase in forage yields shown by present hybrid cultivars.

Similar problems have been experienced in production of hybrid seed of other crops and the use of marker genes to facilitate the separation of seed produced on the MS and pollenizer lines has been suggested (1). An alfalfa plant which produced black seed was discovered at Nevada in 1965. The black seed produced on this plant was about 20% smaller than normal yellow seed of similar lines. A genetic study has established a tentative genetic hypothesis different from that proposed by Mac Vicar (2). Seed color is controlled by four genes with tetrasomic inheritance.

The black seed trait has the potential of solving one of the most serious problems in producing hybrid alfalfa seed, that of identifying and separating hybrid seed from the pollenizer line when two lines are interplanted in a mixed stand. Two possibilities exist for the separation of the black seed from normal yellow seed. Spectroreflectometer curves of the seeds run through a wide range of wavelengths by Central Engineering Laboratories of FMC corporation (3) indicated wavebands of notable difference in reflectance, making color detection a feasible means of sorting these seeds. Color sorting machines with the capability of handling volume quantities of small particles are not available. Seed size offers the best opportunity for separation at the present time. Analysis of the three dimensions of seed of 30 black seeded lines and several standard cultivars indicated that size separation, based on two of the three measurements, would be feasible on some lines especially after genetic manipulation of seed size.

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Performance of Certified Seed Lots of Dawson Alfalfa

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Breeder, foundation, and certified seed lots of 'Dawson' alfalfa, Medicago sativa L., were tested to determine stability in performance during three generations of seed increase under certification.

Dawson is a recent eight-clone synthetic alfalfa variety resistant to pea aphids, Acyrthosiphon pisum (Harris), and spotted alfalfa aphids, Therioaphis maculata (Buckton); intermediate in resistance to potato leafhopper, Empoasca fabae (Harris); and similar to 'Ranger' in resistance to bacterial wilt, Corynebacterium insidiosum McCull H. L. Jens. Breeder, foundation, and certified seed classes are the Syn-1, -2, and -3 generations, respectively.

Two field experiments were conducted, a seeded forage yield test and a spaced-planted test. Greenhouse experiments included separate tests for resistance to pea aphids, spotted alfalfa aphids, and bacterial wilt disease.

Slight variations among seed lots were found for growth habit, winter hardiness, rate of recovery after cutting and insect and disease resistance. These variations occurred within a generation and among successive generations produced inside and outside of the Dawson (northern) area of adaptation.

Seed lots were not significantly different for forage yield and persistence in the seeded forage yield test. Differences among seed lots in the space-planted field test and in greenhouse tests were not of significance to forage yield and persistence in the seeded forage yield test during three years. Continuity in performance of three generations of seed increase under certification procedures was observed.

A given seed lot was aberrant for one trait but was within the same range as other lots for other traits. Thus, tests for more than one economically important trait are needed to evaluate performance of a given seed lot regardless of seed class.

Age of seed field was not important in the performance of seed lots within breeder, foundation, or certified seed classes.

The results obtained on certified Dawson alfalfa seed classes in field and greenhouse experiments were in agreement with the original variety description.

Potentials of European Alfalfa Pollinators

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Alfalfa seed production has been dominated by the Western States where production in the years 1973-75 has ranged from 80-85% of the total U.S. crop. Significantly, the acreage that has produced these crops is but 43-48% of our total alfalfa acreage. Average seed yields per acre for the western states ranged between 411-414 lb/a whereas other states produced 78-86 lb/a (USDA Crop Reporting Board, Statistical Report. Serv. 1976). The primary cause of this large disparity in these figures is inadequate pollination. Western seed growers manage various species of wild bees in order to adequately pollinate their crops, but large alfalfa acreages in South Dakota and Kansas are either not supplemented with wild bees or the honeybee is used for pollination.

The primary pollinator of alfalfa in the western states is the alfalfa leafcutter bee, an introduced European species. The effectiveness of this species as an alfalfa pollinator declines in the warmer southwestern states but here another old world species, the pale leafcutter bee, is becoming more abundant. The pale leafcutter bee is an effective alfalfa pollinator and studies on its management are being conducted. Large blocks of our alfalfa seed-growing regions are without the benefits of either species because these wild bees have not been tried or climatic conditions are not favorable.

In Eurasia, the native home of alfalfa, many pollinators are commonly associated with this plant. Recent studies by Benedek (1973) indicate that there are several European bees that are highly effective alfalfa pollinators. Effective tripping rates by bees of the genera Melitturga, Melitta, and Andrena, range between 85 and 93%. Females of all these genera make nests in the ground and natural populations in Europe can average as high as 5 females/plant. If these bees can be introduced and established in our prairie states, it is conceivable that natural populations could increase alfalfa pollination significantly. Also, some species might lend themselves to management techniques similar to those developed for the alkali bee.

Many other species of bees similar to our already established species of leafcutter bees are commonly found associated with alfalfa throughout Eurasian countries. There is a great potential for introducing, establishing and managing these species in the U.S. where alfalfa is presently inadequately pollinated.

Reference

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Isolation Distances and Border Removal for Alfalfa and Red Clover Seed Production in Canada

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To preserve genetic purity of pedigreed legume seeds in Canada, isolation distances for fields exceeding 2 ha are 183, 91 and 50 m for Foundation, Registered and Certified seed respectively. The development of marker strains of recessive white flowered alfalfa and red clover has made it possible to conduct tests on cross-pollination and to refine existing regulations. Genetically pure marker strains are easily maintained by rogueing and since these marker strains are characterized by a green hypocotyle the rapid analysis of large numbers of seedlings is possible.

Alfalfa. In 1969 a 4 hectare field of a marker strain was planted contiguous (137 m border) to a 4 ha field of the cultivar Beaver. In 1971, 1972 and 1973 approximately 50,000 (17,000 females) leaf cutter bees, Megachile pacifica (Panzer) per hectare were provided. Based on over 2,000 seedlings analyzed for each isolation distance, the average contamination for the 3 years was: 0-1 m, 17.5%; 1-10 m, 5%; 11-20 m, 2.5%; 21-30 m, 1.7%; 31-60 m, 2.5%; 61-200 m, 1.1%. Thus a 10 m border on a contiguous field would result in contamination of less than 2%. Where large concentrations of leaf cutter bees are used, border removal and a much reduced isolation distance could be a reasonable alternative to existing regulations.

Red Clover. In 1970 a contaminant plot of 1.32 ha (96 x 137 m) of the cultivar Lasalle and 1.37 ha of a white-flowered selection of Lasalle consisting of 2 replicates of 20 x 183 m contiguous plots (contiguous on 20 m) and 32 x 32 m plots at 45, 91, 183 and 274 m were planted. In 1971, 10 colonies of honey bees (3.8 col/ha) were provided. Over 6,000 seedlings were analyzed from each plot. In the contiguous plots the contamination was 11.7% at 0.5 m and from 5-183 m the 0-2 perimeter and 5.0% contamination compared with 2.9% in the rest of the plot. In the other isolation distances, a comparison of a 2 m border with the rest of the plots indicated contamination of 4.5: 3.2% at 45 m; 3.5: 2.6% at 91 m; 2.5: 2.1% at 181 m; and 2.6: 1.0% at 274 m. In 1972 some of the marker plots were plowed. The contaminant-marker ratio was 4:1 and contamination was twice that of 1971.

In large fields of red clover grown for certified seed, and where contamination acreage ratio is low, removal of a 2-3 m border with a reduction of isolation distance may be recommended. For small acreages of Foundation and Registered seed where nearby contaminant acreage is large, it may be necessary to make border removal mandatory to ensure genetic purity in legumes.

In comparing alfalfa and red clover it would appear that leaf cutter bees because of their shorter range result in lower contamination in alfalfa than the more wide-ranging honey bees on red clover. In addition to range, seed yield may also be a factor in contamination. Another factor is antagonism between bee species which may also influence contamination.

Progress in Alfalfa Variety Protection

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The Plant Variety Protection Act protects new and novel cultivars reproduced by seed. To receive protection the cultivar should be fully described and distinct from other cultivars. The descriptions and differences should be supported by appropriate verification.

Seventeen applications for protection of alfalfa cultivars have been received. Ten of the applications are from private industry, four from experiment stations and three from foreign applicants. Eight of the applicants have chosen to have their variety sold only as a class of certified seed.

The descriptive form for alfalfa has been completed with the aid of many alfalfa experts. The form is intended to allow description of alfalfa cultivars from their basic characteristics in a uniform manner. Comparison cultivars have been used as an aid in standardizing the descriptions. This will allow comparison of all cultivars through these standardized descriptions.

We have searched the available literature and compiled descriptions of cultivars. The descriptions are rather brief and general. Many disease reactions are listed only as resistant or susceptible and flower color is is given as mostly purple or variegated. More cultivars could be differentiated if cultivars were described in more detail. Many of the cultivar descriptions in the literature describe the agronomic attributes or value of the cultivars. They sometimes omit the more basic descriptive characters.

Your assistance will be needed to describe cultivars for characters omitted from the present descriptions. We will also be asking for assistance in pointing out differences between cultivars.

Plant variety protection exhibits have been changed recently and the changes have been published in our journal. The changes have been made to eliminate duplication and improve the descriptions received. The application form and Exhibit A ask for the same information requested previously. Exhibit B is now the novelty claim formerly requested as Exhibit D. The novelty statement should clearly show that the variety is novel. Exhibit C remains the objective description and this has been described previously. Exhibit D is for additional description that has not been covered in previous exhibits. Data or other verification should also be included. Exhibit E has been eliminated as a separate exhibit and incorporated into the application form.

Recurrent Selection for Alfalfa Seed Yield

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Phenotypic recurrent selection for alfalfa (Medicago sativa L.) seed yield under irrigated Idaho conditions was made for 1 to 2 cycles in each of 16 genetically diverse populations from 6 North Central states. The populations were of multiple-clone or other broad-based origin. For a given cycle of a population, 1000 seedling plants were transplanted to the field in early spring in 2' x 2' spacings. Management practices were used to maximize seed yield. In August of the same year, 5 to 10% of the plants in a population were visually selected by the originator for total seed yield. Selected plants were interpollinated using bee, hand, or both types of pollination to produce Syn-1 generation seed. Syn-2 seed of some populations was produced in bee-pollinated cages.

Seed yields of the Syn-1 or -2 generation of parental populations and the Syn-1 or-2 of populations derived from 1 to 2 cycles of seed yield selection were determined in irrigated tests in California and Idaho for 2-year periods. Management practices were used to maximize seed yields. Data on forage yields, insect and disease resistance, growth habit and other traits were obtained on Kansas and Nebraska materials in the respective states of origin.

Recurrent selection for seed yield in Idaho was not effective in changing 1974-75 seed yields in Idaho, based on a combined analysis of 8 populations from 4 states and one cycle of selection. In the analyses within states, entries from Illinois differed; populations differed from Illinois and Minnesota, but seed yields were not changed by one cycle (Nebraska and S. Dakota) or two cycles (Illinois, Kansas and Minnesota) of selection. However in the Kansas population, parental and cycle 2 Syn-2 yields were the same but cycle 2 were higher than cycle 1 Syn-2 yields. Seed yields of one parental population from Illinois, and two each from Minnesota and Nebraska were in the same range as 'Vernal'. Other parental populations ranged in yield from 65 to 80% of Vernal.

In other 1973-74 work, two cycles of seed yield selection in Idaho did not change Idaho seed yields of an Alaskan population. Six entries from Kansas differed in Idaho where the Syn-1 seed yield of a cycle 2 population was higher than that of the parental Syn-2 population. However, results from simultaneous testing of these Kansas entries in California showed no differences among entries or cycles. Similarily,Nebraska Syn-2 entries, tested simultaneously in California and Idaho, differed in Idaho where seed yield decreased with one cyle of selection in 1 of 3 populations; however, entries did not differ, and parental populations did not differ from cycle 1 populations in California. Seed yields of one Kansas and two Nebraska parental populations were in the same range as Vernal, whereas others varied from 80 to 93% of Vernal.

Selection for seed yield did not change forage yield, level of insect or disease resistance, or other traits in Kansas and Nebraska populations.

Pyroxychlor Seed Treatment to Control Alfalfa Seedling Diseases Caused by Pythium, Phytophthora, and Peronospora

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Pyroxychlor [2-chloro-6-methoxy-4- (trichloromethyl) pyridine], formerly Dowco 269, is translocated downward in plants. When applied as a soil drench or foliar spray, it shows systemic activity against soil-borne pythiaceous fungi. To determine its efficacy as a seed treatment, we applied technical pyroxychlor to alfalfa seed at various rates (w/w) and evaluated seedling reactions.

Kanza seed was treated at rates of 0, 1/8, 1/4, 1/2, 1 or 2% and planted in greenhouse (22-32 C) in soil naturally infested with Pythium spp. Seedling survival (as percent of seeds planted) two weeks later was 14, 13, 82, 79, 90, and 66% [LSD (P=0.05)=8], respectively. The 2% rate was phytotoxic.

Pyroxychlor gave sufficient seedling protection to complement the Phytophthora-resistance of Agate and thereby increased the stand in soil heavily infested with P. megasperma (Table 1). The protective period by different rates of pyroxychlor is shown by the relative survival time within Kanza, a susceptible cultivar.

Table 1. Mean survival (as percent of seeds planted) of Agate and Kanza alfalfa seedlings from pyroxychlor-treated seed planted in soil infested with Phytophthora megasperma and maintained at 20 C with a 16-hour photoperiod of 10 klx

Pyroxychlor rate (% of seed wt.)	Percent of plants living at indicated time after planting: Agate					Kanza				
	1 wk	2 wks	4 wks	6 wks	8 wks	1 wk	2 wks	4 wks	6 wks	8 wks
0	30	4	4	4	3	32	2	0	0	0
1/4	57	45	37	36	35	44	20	10	4	1
1/2	56	56	48	45	44	62	48	30	13	3
3/4	57	55	55	55	54	45	40	21	12	4
1	49	44	44	44	44	56	47	44	30	4
LSD 0.05	17	12	10	8	5	17	12	10	8	5

Downy mildew incidence in 11-day-old Kanza seedlings from pyroxychlor-treated seed varied greatly among experiments, but averaged near 50% for the 3/4 or 1% rate compared to 99% in untreated controls. Mildewed plants from treated seeds had much milder symptoms than did those from untreated seeds.

Pyroxychlor had no apparent affect on Rhizobium nodule formation on alfalfa roots.

Incidence of Alfalfa Mosaic Virus Infected Plants in Fourteen Alfalfa Varieties

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Alfalfa mosaic virus (AMV) is of particular concern because of its widespread occurrence in most alfalfa fields. It has been known to adversely affect yield but the percentages of reduction in alfalfa forage yield due to AMV infection found by many researchers have been quite varied (1,2,3). With 30 million acres devoted to alfalfa production in the United States, even conservative estimates of yield reduction due to AMV infection will result in economic losses that run into millions of dollars.

So far, no adequate method has been developed to control AMV in alfalfa. The development of resistant alfalfa varieties would be an adequate means of eliminating or at least reducing yield losses.

In an attempt to isolate AMV resistant germplasm and to determine if varietal differences in reaction to AMV existed, plants in forage yield trial plots seeded in 1970 at Brookings, South Dakota, were assayed for virus infection on garden bean (Phaseolus vulgaris 'Bountiful') during the 1975 growing season. All fourteen host varieties were infected with alfalfa mosaic virus. Although there were large differences in the incidence of AMV among the varieties, these differences were not significant at the .05 level. Individual plot incidence values ranged from 22 to 94%. When averaged over four replications the highest incidences occurred in Ladak, Fremont and Atlantic with 69, 72 and 73% respectively. Dawson and N.C. 60 Syn-2 had the lowest incidences with 47 and 48% respectively.

Regression analysis between AMV incidence and yield substantiated the adverse effect of incidence on yield but not on stand.

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Present Status of Sclerotinia Crown and Stem Rot in Alfalfa

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Sclerotinia crown and stem rot of alfalfa is sporadic in occurrence and scattered within plantings. Losses may involve areas 6-8 cm in dia or entire fields. Although plants of all ages are susceptible, the incidence and severity of disease is greatest in seedlings. Despite previous publications on the pathogen, the disease cycle, host range, and some control data, the necessary epidemiological knowledge is lacking for substantial reduction or elimination of crop losses or for the creation of epidemics to evaluate progress in disease control.

To study ascospore discharge, apothecia of Sclerotinia trifoliorum were collected in an alfalfa field on 25 Nov, 2 Dec, and 16 Dec 1975 and incubated on 2% water agar in petri dishes at 4 to 36°C in 4°C increments. After 3 and 6 hrs, apothecia were transferred to fresh dishes and returned to the incubators; at 14 hrs the apothecia were discarded. Ascospores were counted in 14.2 mm^2 area and germ tube length was measured. Generally, ascospores were discharged sooner at higher than at lower temperatures. For example, at 36°C spore counts between 0-3, 3-6, and 6-14 hrs were 67,983, 4,055, and 3,053 respectively. At 28°C counts were 15,136, 38,426, and 24,794, respectively, and at 20°C counts 12,465, 3,249, and 38,247, respectively. To determine the duration of ascospore discharge, apothecia were incubated at 24°C for 124 hrs. Counts were made after 1, 2, 3, 4, 5, 6, 8, 11, 26, 27, 28, 52, 76, and 124 hrs. The cumulative total discharged was 176,019 (avg from 5 microscope fields for each of 6 apothecia); 95% of the ascospores were discharged by 26 hrs. Ascospores continued to be discharged throughout the 124 hrs period. Optimum temp for germ tube growth was 24°C.

To determine fungicidal control of S. trifoliorum, 5x10 ft plots (6 reps) of 'Team' alfalfa, seeded 16 Sept 1974, was sprayed with benomyl (.5 lbAI/A) at monthly intervals beginning 15 October. The disease was first observed 16 Jan 1975. On 17 March 1975 disease damage in the non-sprayed check averaged 25.2% of the plot; the damage in plots sprayed monthly averaged 1.1%. Damage in plots sprayed once in either Oct, Nov, Dec, Jan or Feb averaged 15.0, 8.7, 8.3, 27.1, and 26.6%, respectively.

Two strain tests, containing 5 reps. of 18 and 6 reps. of 26 entries of wide-varying germplasm, planted the fall of 1973 and 1974, respectively, were evaluated for Sclerotinia crown and stem damage on 8 March 1974 and 28 March 1975, respectively. In 1974, damage in NCW21, NCMP2, Victoria, and Kanza was 0.5, 0.7, 3.9 and 5.7%, respectively (LSD .05, 2.87). In 1975, damage in the same 4 entries in the second test was 8.9, 3.3, 29.5 and 19.6%, respectively (LSD .05, 6.51). Damage was significantly less in the locally developed experimental alfalfa varieties NCW21 and NCMP2. These varieties had been developed through long-term recurrent field selection in North Carolina.

Inheritance of Bacterial Wilt Resistance

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Barnes, et al. (1) selected two cycles in MSA population and four cycles in MSB for bacterial wilt resistance. More rapid response in MSA appeared to indicate either different genetic mechanisms or different gene frequencies in the original populations. In this study we tested seven cycles from MSA and nine cycles from MSB to determine response to selection. More rapid response was observed in MSA. The curve from MSA was quadratic whereas MSB was linear.

This research was conducted to determine reasons for differential response in MSA and MSB to bacterial wilt resistance. Plants were selected to represent each disease severity class. Cuttings made prior to inoculation were used as parents for selfs and reciprocal crosses to be utilized in both qualitative and quantitative genetic analyses. Information from three sets of intrapopulation diallels and two sets of interpopulation Design II's were used in quantitative analyses. Qualitative analyses consisted of testing observed segregations against expected. Plants were scored 0 (healthy) to 5 (dead) 14 weeks after inoculation.

A tentative genetic hypothesis has been formed from set I of the MSA, MSB and MSA x MSB designs. Three genes with major effects appear to explain the observed segregations. MSA contains a gene dominant for resistance that may explain the rapid response to selection. Both MSA and MSB contain a gene in common for susceptibility that acts in an additive manner. In addition, MSB contains a gene for resistance that acts in an additive manner. Quantitative analyses indicate significant GCA and SCA, however, GCA is much greater. Significant reciprocal differences were found in only two of eight analyses.

Anatomical and physiological differences have been reported in literature for varieties with different degrees of resistance. These include fewer vascular bundles, shorter vessel elements with heavier wall thickenings, and a thicker cortex in roots of resistant varieties. The vessels have been observed to be grouped together and surrounded by wood fibers. The parenchymatous tissue contain smaller intercellular spaces. In addition, a phytotoxin has been isolated from the pathogen. These differences suggest more than one genetic mechanism. The data from this study may tie the literature together and resolve the inconsistencies in bacterial wilt inheritance studies. It appears that everyone may be correct!

Reference

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Evaluating Alfalfa for Reaction to Fusarium Wilt and Fusarium Wilt-Bacterial Wilt Combined

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Objectives of this study were to determine if: 1) our greenhouse procedures for inoculating with Fusarium wilt (FW) could be successfully applied to field trials, 2) differences in cultivar reaction to FW could be detected, 3) determine if FW and bacterial wilt (BW) symptoms in the roots could be readily distinguished, and 4) resistance to other root pathogens was associated with reaction to FW.

Plants of seven cultivars of alfalfa (Medicago sativa): Agate, Arc, Ramsey, Salton, Team, Vernal and WL318 and five experimental lines: MnPL-1, MnPL-2, MnPL-4, Team WR-3, and 69-T10 were inoculated with three local isolates of Fusarium wilt (Fusarium oxysporum f. sp. medicaginis), bacterial wilt (Corynebacterium insidiosum) alone and in mixture and transplanted into the field.

About 12 weeks after transplanting the plants were lifted, the tap roots sectioned and the disease severity, based on internal root discoloration, for each plant was recorded. Disease severity ratings were based on a 0-5 scale. 0 = no discoloration in the root and 5 = a dead plant.

The average disease severity and percent dead plants among the entries ranged from 2.01 and 27% in Salton to 4.05 and 76% in MnPL-4. This assured us that the procedure is satisfactory for comparing cultivar reaction to FW. FW killed most of the susceptible plants during the season and about 90% of the plants killed were dead within 5 weeks after transplanting.

The mixed inoculum resulted in a small percentage of surviving plants with symptoms of both diseases. The symptoms of each disease could be identified. FW caused a dark brown discoloration in the stele and the discoloration appeared limited by certain vascular tissues. BW caused a yellowish-brown discoloration in the stele and it was more diffuse.

The average disease severity due to the mixed inoculum was slightly greater than that due to FW alone in all entries but one. The differences, however, were much smaller than would be expected if each pathogen acted independently. The percentage of dead plants was about the same from the mixed inoculum as FW alone. The percentage of dead plants from BW alone was negligible. The percentage of live plants with bacterial wilt symptoms from the mixed inoculum was much lower than for plants inoculated with BW alone. Fusarium apparently had an inhibitory effect on the bacteria.

In another test 71 cultivars and 10 experimental lines were inoculated with FW inoculum and cultured as previously described, using the same isolates. The average severity indexes and percent dead plants among the entries ranged from 1.73 and 13% to 4.78 and 92% respectively. The non-winterhardy cultivars, as a group were the most resistant and the Flemish cultivars, the most susceptible. Cultivars in the winterhardy group ranged in disease severity from 2.23 to 4.20 and in dead plants from 24 to 66%.

About 120 of the most resistant plants selected from the MnPL-5 population were intercrossed and the intercrossed progenies evaluated for FW resistance. The average disease severity was reduced from 3.93 to 2.26, the percent dead plants from 68 to 33 and the percent resistant plants increased from 15 to 55 in one cycle of recurrent selection. This indicated to us that our techniques are reliable and that relatively rapid progress can be made in selecting for Fusarium wilt resistance.

Pest-Pathogen Resistance and Photosynthetic Rate in Alfalfa

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A number of alfalfa (Medicago sativa L.) lines have been developed that have varying degrees of resistance or tolerance to disease, insects, and nematodes. Some information is available concerning the interrelationships among the different types of resistance. Little is known, however, about the relationship between resistance and photosynthetic rate. I grew 22 different alfalfa lines under glasshouse conditions and measured photosynthetic rates of attached leaves in controlled environment chambers. The observed net carbon dioxide exchange rates indicate that no shift in photosynthetic potential has occurred with the selection for disease, insect, or nematode resistance. The data also provide a comparison of photosynthetic rates among alfalfa cultivars.

Interaction of Fusarium Root Rot with Pea Aphid and Potato Leafhopper Feeding on Forage Legumes

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The interaction of insect feeding and Fusarium root rot was investigated in greenhouse, growth chamber and field insectary tests with red and white clovers and alfalfa. Insects used as stress factors were the pea aphid, Acyrthosiphon pisum (Harris), and the potato leafhopper, Empoasca fabae (Harris). In every experiment, significantly more rot developed in plants subjected to pea aphid feeding but inoculated with Fusarium. More red clover plants died in the combined Fusarium-aphid treatment than in any other treatment. The combination of potato leafhopper feeding with Fusarium root rot resulted in a significantly higher death rate of plants over the following winter, than occurred in the untreated control. Highly significant interaction between insect feeding and Fusarium was demonstrated for days until death of red clover and alfalfa, winterkill of alfalfa, and internal rot incidence with all forage species.

The interaction of insect feeding with the development of root and crown rots is important because it points out the fallibility of considering insects and diseases as separate, discrete problems. They are not. Perennial forages are subjected to a series of biotic and abiotic stresses over several years that occur sometimes simultaneously, sometimes sequentially, but always cumulatively.

The Role of Bacteria Other Than Corynebacterium insidiosum in Root Disorders

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Several early authors have reported associations of Gram negative bacteria with root rot and wilting of alfalfa. However, these reports lacked sufficient physiological data to permit classification by current practice.

Alfalfa plants from cultivars generally considered to be resistant to bacterial wilt (C. insidiosum) but exhibiting typical wilt symptoms were collected in Eastern Pennsylvania. Standard isolation procedures failed to yield C. insidiosum but consistently yielded fluorescent pseudomonads and Erwinias along with species of Fusarium. Physiological tests in vitro, pathogenicity tests on two alfalfa cultivars and hypersensitive response tests on tobacco were conducted. Six Pseudomonas-like isolates and an isolate of Pseudomonas marginalis reacted similarly to most of the physiological tests. In greenhouse studies, seedlings of both wilt resistant (Buffalo) and wilt susceptible (Du Puits) cultivars collapsed suddenly and died or developed yellow leaves which later wilted. The roots of dead plants in most cases had soft-rot of tap and feeder roots. The alfalfa isolates differed from P. marginalis in their ability to induce the hypersensitive response in tobacco. Nevertheless, we propose the name P. marginalis var. alfalfae (PMA), based primarily on physiological characters. Results of the physiological tests on 6 Erwinia-like isolates suggests that they belong in the 'amylovora' group of the genus. The alfalfa isolates were physiologically and serologically distinct from three known phytopathogenic Erwinias. Pathogenicity tests conducted in the greenhouse revealed slight to moderate root necrosis, leaf chlorosis and sometimes plant death. Although the alfalfa Erwinias differ from Erwinia amylovora by their failure to induce the hypersensitive response in tobacco, we propose the name E. amylovora var. alfalfae (EAA) based primarily on physiological characters.

Interactions between 3 alfalfa root pathogens; CI, Fusarium oxysporium f. sp. medicaginis (FOM), and F. tricinctum (FT), and 2 root bacteria; PMA and EAA, were investigated in greenhouse studies on Buffalo and Dupuits. The PMA-CI and EAA-CI combinations were antagonistic and reduced foliar symptoms in both cultivars. The combinations PMA-FT and EAA-FOM were synergistic on both cultivars while the PMA-FOM and EAA-FT combinations exhibited this response only in the Buffalo and Dupuits cultivars, respectively. This differential synergisim on Buffalo and Dupuits revealed by the root bacteria and Fusaria spp. combinations, emphasizes the host's role in these interactions.

Improved Growth and Yield of Crops from Organic Supplements

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Recent increases in the cost of chemical fertilizers due to increases in the price of petroleum and the overall diminishing supply of natural resources has renewed interest in improving the efficiency of fertilizer utilization. In modern times the extensive use of chemical nitrogen fertilizers has diminished the emphasis placed on organic fertilizers.

Plant materials were investigated as sources of fertilizer, including the use of conventional fertilizer application methods. Alfalfa hay and soybean meal increased growth and yield when placed in a band below and to the side of crop seeds or plants. This was achieved with rates of 190 to 470 kilograms of alfalfa per hectare containing 5 to 12 kilograms nitrogen per hectare. The increase in growth or yield of rice, tomatoes, cucumbers, lettuce, cauliflower, and corn was greater than equivalent amounts of nitrogen fertilizers.

Plants responded best to placement of the organic material below and to the side of the plant or seed. Tests for nematode control or a mycorrhizal relationship due to the presence of alfalfa proved negative. The alfalfa meal was effective on several soil types including muck or peat. Plants responded to straw applied similarly to the alfalfa on muck soils, but failed to respond on loamy sand. Corn seedlings receiving a supplemental application of alfalfa weighed more and the leaf area was greater than the control or nitrogen treatment. The roots in the alfalfa treatments were also larger than those from the supplemental nitrogen treatment resulting in a lower shoot to root ratio. These results suggest that small quantities of plant material banded by crop plants or seed may substitute for supplemental applications of inorganic nitrogen fertilizers. Inorganic and synthetic fertilizers will still be necessary for supplying the major portion of applied nutrients for crops.

Combining Ability Effects for Pest Resistance in Selected Alfalfa (Medicago sativa L.) Clones

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Diallel cross progenies, including reciprocals, of 6 alfalfa (Medicago sativa L.) clones that differed in mirid-induced leaf malformation and aphid resistance were studied to obtain estimates of combining ability effects for characters associated with resistance to the spotted alfalfa aphid (SAA) Therioaphis maculata (Buckton), the pea aphid (PA) Acyrthosiphon pisum (Harris) and two mirids: the alfalfa plant bug (APB) Adelphocoris lineolatus (Goeze), and the tarnished plant bug (TPB) Lygus lineolaris (Palisot de Beauvois). The responses to mirid feeding were measured in the field with controlled APB and TPB infestations under cages. Aphid tests were conducted on seedlings in the greenhouse.

The absence of any significant genotype x mirid species interaction indicated that the same genes conditioned the observed genotypic responses to both APB and TPB feeding. Forage yield and stem length were reduced 5 and 20%, respectively, while percentages of dry matter were unchanged and protein percentages increased 4% due to mirid infestation. Resistance to mirid-induced forage yield reduction and stunting was not found. Leaf malformation, a symptom of mirid feeding, appeared to be a highly heritable trait, but was not correlated with forage yield reduction, stunting, forage quality or aphid resistance.

General combining ability effects (GCA) were far more important than specific combining ability effects (SCA) among single crosses for forage yield, stem length, and leaf malformation under mirid infestation, and for PA and SAA resistance. Resistance to PA and SAA was conditioned by different genes.

Progress In Breeding For Improved Nitrogen Fixation Potential In Alfalfa

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Nitrogen is an essential element for plant growth. Future supplies and cost of petroleum based nitrogen fertilizers are uncertain. This, plus the fact that, alfalfa has a greater potential for producing large amounts of symbiotically fixed nitrogen than other major agricultural crops, encouraged us in 1974 to establish a program to breed for improved nitrogen fixation potential in alfalfa.

More than 2,000, 6-month-old plants from 6 varieties were observed for degree of nodulation. Seventy-seven plants were selected as being either high or low nodulators. These selections were reevaluated in replicated tests and also evaluated by an acetylene reduction procedure for nitrogen fixation potential. Significant differences were observed among clones for root morphology, nodulation, and N_2 fixation. The acetylene reduction procedures developed for use with alfalfa provided good uniformity between tests and indicated that differences among clones was repeatable.

Three high N_2 fixing clones and three low N_2 fixing clones were crossed in a diallel design. Thirty-six plants from each of the 15 crosses, plus the varieties Agate and Saranac were evaluated in the same test. High x high crosses had significantly more fibrous roots, better nodulation, larger root weight and greater acetylene reduction values than the low x low crosses. High x low crosses tended to be intermediate. Increases in fibrous root scores were significantly correlated with increases in amount of nodulation ($r = .86^{**}$, 34 d.f.). This was thought to reflect the fact that more sites encouraged greater nodulation. Factors significantly correlated with acetylene reduction were fibrous roots ($r = .63^{**}$), nodulation ($r = .68^{**}$), top weight ($r = .34^{*}$) and root weight ($r = .38^{*}$). It was concluded that N_2-fixation potential as measured in greenhouse studies was sufficiently heritable to warrant establishing a breeding program for the trait.

Field trials will be needed to establish the relationship between greenhouse and field data. Therefore, preliminary field trails were established to measure N_2-fixation during the seedling year. Plots (6.2 x 1.7m) were planted in early May. Forage harvests were made in July, August, and October. Plots were plowed in October. In May of the following year soil samples were taken from each plot and sorghum-sudangrass was planted over the entire plot area. Relative ranking of N_2 removed in forage of sorghum-sudangrass and N_2 indicated by soil analysis was similar. However, sorghum-sudangrass appeared to be a preferred procedure for N_2 analysis because it provided a indication of time of release.

Greenhouse and field results to date appear to indicate that it should be possible to improve the nitrogen fixation capacity of alfalfa. However, it will require a concentrated team effort of breeders, microbiologists, physiologists and forage production specialists to maximize progress in this area of research. Such a concentrated group effort is being developed at St. Paul by ARS, USDA and University of Minnesota personnel.

Breeding a Non-bloating Alfalfa Cultivar

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Initial efforts for breeding a non-bloating alfalfa were based on screening for low soluble fraction I genotypes. Reinvestigation of the soluble proteins however, revealed that fraction II proteins were similar to fraction I protein in being denatured and insolubilized by foaming. Hence it was concluded that breeding for non-bloating alfalfa should be based on total soluble protein. This conclusion was further substantiated by bloat incidence trials carried out at Kamloops, B.C. In this 3-year study it was found that soluble protein nitrogen was most closely associated with bloat incidence.

In a study carried out in 1972-73, narrow sense heritability estimates were obtained for fraction I, fraction II and total soluble protein (fractions I and II). Heritability estimates (h^2) were based on the parent-offspring regression method using data from 32 unselected clones and their open-pollination progenies. The h^2 estimates obtained are shown in Table 1. These relatively low heritability estimates indicate that it should be possible to lower soluble protein content of alfalfa by consecutive cycles of recurrent selections involving replicated progeny tests. To this end we are currently screening 750 P/C progenies for soluble protein using freeze-dried samples and a modified biuret test (Howarth et al. 1973). Analyses are also being done on total N to ensure that selection for low TSP will not lower total protein. Lines with low and high levels of TSP are being selected concurrently to measure the relative success of selection. A high TSP alfalfa would also be a desirable plant source for future protein needs.

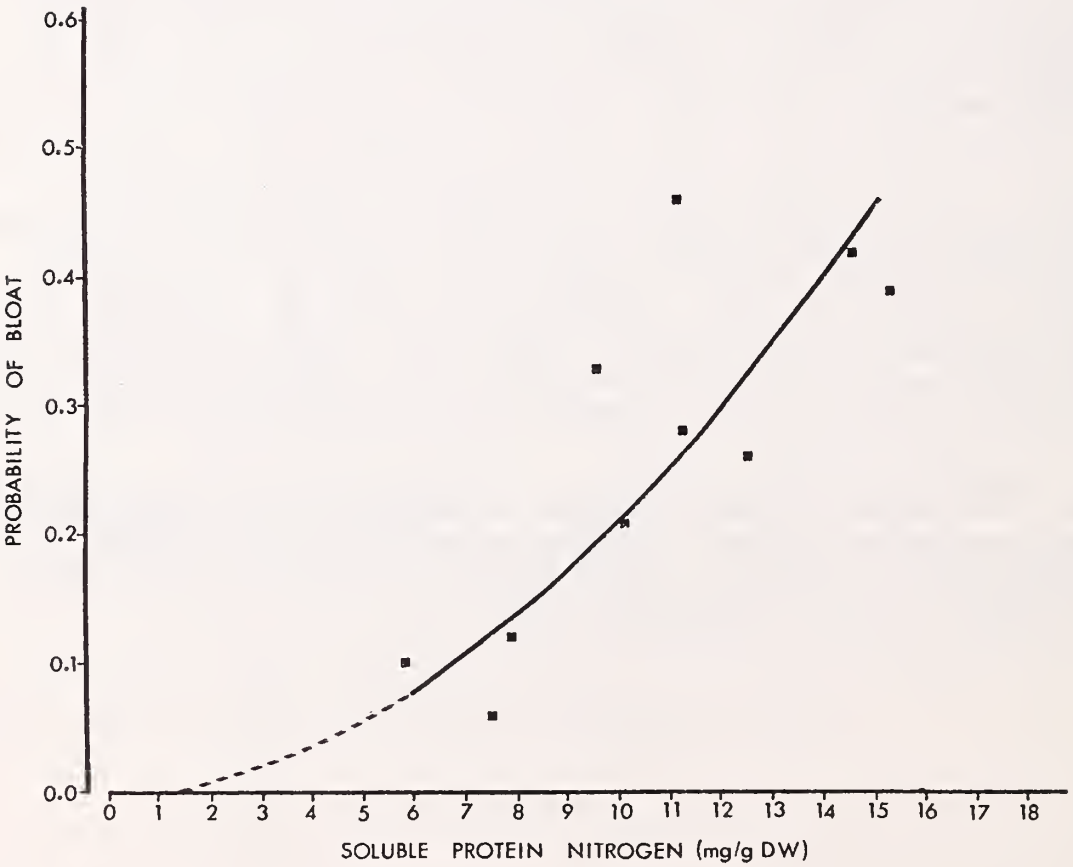
In a bloat incidence study conducted at Kamloops, bloat incidence was related to various nitrogen and protein fractions. As previously indicated, it was found that bloat incidence most closely associated with soluble N and soluble protein N. This curvilinear relationship is illustrated in Figure 1. From this figure it may be seen that lowering the soluble protein N from an average of 10 mg/g down to 5 mg/g would lower bloat incidence from .25 to approximately .05. Hence progress in this program will result in a progressive lowering of bloat incidence in cattle fed fresh alfalfa herbage.

It has been found that most non-bloating legume species contain condensed tannins. An extensive search throughout perennial and annual Medicago spp. has not revealed any species containing condensed tannins. However, a mutation nursery of M_2 plants (2N and 4N) is currently being screened for tannins using a modified vanillin-HCl test.

Table 1.--Heritabilities of soluble proteins in alfalfa

Soluble protein fraction	Heritability (h^2 = 2b x 100)	
	1972	1973
Fraction I	19.6	20.2
Fraction II	19.6	27.1
Total (I + II)	23.3	31.0

Figure 1.--Relationship between bloat incidence and soluble protein nitrogen



Current Philosophies in Breeding for Yield

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and

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The recent history of alfalfa breeding provides insight into "current philosophies" of yield improvement. The number of new cultivars per year has increased rapidly; of 122 certified cultivars in our survey, 15 were developed before 1962 and 53 after 1970. The frequency of narrow-based cultivars has remained relatively static; about 10% of the cultivars certified in each time period of our survey had four or less parents. The average number of parents per cultivar has increased, however. About 20% of the cultivars certified between 1963 and 1970, and about 40% of those certified after 1970 had more than 50 parents. These shifts in number of parents per cultivar may reflect increased emphasis on population improvement for one or a few traits (often resistance to a disease or insect pest) and decreased emphasis on progeny testing by some breeders.

Progress in breeding for yield was evaluated by comparing yields of cultivars certified since 1970 with the yield of Vernal in trials reported by the Central and Eastern Alfalfa Improvement Conferences. Yields of the newer cultivars averaged 103% and ranged between 90% and 120% of the yield of Vernal. Among the newer cultivars, some were consistently superior over wide areas, some were superior at specific locations, and a few were uniformly poor.

Much of our current philosophy in breeding for yield is to improve traits that indirectly affect yield, especially disease and insect resistance. The superiority of resistant cultivars at locations where specific disease and insect pests are a problem is evidence that this approach has been quite successful. However, the resistant cultivars often show little advantage when grown in the absence of specific pests. The philosophy of indirectly breeding for yield could be continued by breeding for a greater response to fertilizers, better adaptation to high plant populations, good fall growth combined with winterhardiness, more rapid spring growth and recovery after cutting, better root systems for more efficient fertilizer and water use and resistance to heaving, resistance to machine and animal traffic, tolerance to pesticides, and adaptation to management programs that permit an extra harvest each season.

We do not wish to imply that efforts to increase yield per se should be decreased. Potentially fruitful approaches for increasing yield include more efficient methods of identifying outstanding parents early in breeding programs, increased efficiency in combining diverse germplasms, and research to solve the seed production problems associated with using cytoplasmic male sterility in the production of hybrids.

Eastern Alfalfa Improvement Conference Report

HEINZ GASSER
Service des Stations de Recherches
Direction générale
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The Eastern Forage Improvement Conference (EFIC) met for the first time at the University of Guelph, Ontario, July 16 to 18, 1975. A motion adopted at the 17th EAIC at Blacksburg, Va., on July 26, 1975, specified that the EAIC retain its identity within the Eastern Forage Improvement Conference. The present report reflects the activities of alfalfa workers of the Eastern United States and Canada. The second EFIC will be held at The Pennsylvania State University in July 1977. The officers of the Conference will be Chairman, H. Gasser; Vice-Chairman, A. M. Decker; and Secretary, J. H. Elgin.

1976 ALFALFA RESEARCH ACTIVITIES

University of Connecticut, Storrs

Weed investigations--R. A. Peters and W. M. Dest. Weed control in alfalfa seedings.
Agronomy--R. A. Peters. No-tillage establishment of forage grasses and legumes.
Testing--W. W. Washko. Variety evaluation of alfalfa in field tests.

University of Maryland, College Park

Management--A. M. Decker, N. A. Clark, J. H. Vandersall, and R. F. Davis. Sod-seeded alfalfa, red clover, and crownvetch seedings evaluated under grazing conditions.
--N. A. Clark and J. H. McNemar. Alfalfa cutting management of improved varieties under three fertility regimes.

Rutgers--The State University of New Jersey, New Brunswick

Weed control--R. D. Ilnicki. Control of winter annual and perennial weeds in dormant alfalfa.
Management--M. A. Sprague. Safe time of fall cutting of alfalfa as determined by variations in the microclimate.

New York State College of Agriculture, Cornell University, Ithaca

Agronomy--G. W. Fick and R. R. Seaney. Effect of alfalfa weevil on alfalfa yield, quality, and morphology (in cooperation with Plant Breeding and Entomology). Effect of management, companion crop, and lipid levels on winter survival and yield. Effect of environment on quality and development. Weed control

(with W. B. Duke and R. R. Hahn). Fertility management (with D. R. Bouldin, D. J. Lathwell, and W. S. Reid).
Animal science--P. J. VanSoest, T. J. Reid, C. Coppock. Methods of evaluating quality of forages for ruminants.
Entomology--G. G. Gyprisco, R. G. Helgesen. NSF integrated pest management program. Dynamics and control of alfalfa weevil, alfalfa blotch leaf miner, alfalfa snout beetle, and potato leafhopper.
Plant pathology--R. L. Millar. Determining the nature of resistance mechanisms that limit susceptibility of forage legumes to particular fungal pathogens including the role and action of phytoalexins and cyanogenesis.
Plant breeding--R. P. Murphy, C. C. Lowe, W. D. Pardee. New cultivar development, evaluation, and release. Development of new tetraploid and hexaploid germplasms from previously unused diploid and exotic tetraploid species. Genetic and management effects on forage quality. Selection for high protein and low fiber. Selection for tolerance to leafhopper, alfalfa blotch leaf miner, alfalfa snout beetle, and Phytophthora root rot. Use of inbred lines in cultivar development. Use and distribution of pure seed and surveys of trends in farm use and opinion on alfalfa seed.

Northeast Regional Plant Introduction Station, Geneva, N.Y.--D. D. Dolan, S. W. Braverman, B. J. Fiori, W. R. Sherring. Some promising alfalfa introductions from two plantings: 1974 and 1975. A more detailed report is available.

University of New Hampshire, Durham

Management--Estes and Koch. Influence of potassium on physiology, yield, and persistence of alfalfa.
--Koch, Dunn, Estes, Frick, Mitchell, Schwab. Methods and economics of establishing legumes and productive grasses by minimum tillage.

Nova Scotia College of Agriculture, Truro

Testing--J. S. Bubar. Regional testing and screening of alfalfa cultivars.

Research Station, Agriculture Canada, Charlottetown, P.E.I.

Crop physiology--Michio Suzuki. Factors influencing winter survival of alfalfa.
Breeding--C. Willis. Screening alfalfa for root lesion and root knot nematode resistance.

The Pennsylvania State University, University Park

Breeding and cytogenetics--R. W. Cleveland, M. L. Risius, and J. S. Shenk. Variety evaluation in field trials. Evaluations for resistance to anthracnose and bacterial wilt. Breeding for persistence. Development of creeping-rooted alfalfa lines.

Entomology--A. A. Hower. Impact of alfalfa harvest on alfalfa weevil parasitoid Microctonus aethiopoides.
Plant pathology--F. L. Lukezic. Host-parasite interactions between alfalfa plants and Corynebacterium insidiosum. The role of bacteria other than C. insidiosum in root disorders of alfalfa.

Weed investigations--N. L. Hartwig. No-tillage legume seedings into bluegrass pastures.
Management and production--J. B. Washko, K. T. Leath, A. A. Hower, E. M. Kesler, W. C. Downs III, and L. F. Marriott. Management factors on alfalfa productivity and persistence. Evaluation of pastures for dairy heifers. Development of seeding techniques and management systems for feed crops in southwestern Pennsylvania.
Engineering--W. L. Kjelgaard. Engineering systems for forage crop production and use. Linear program model of forage movement and machine activities from field to storage.
Nutritive evaluation and utilization--J. S. Shenk, B. R. Baumgardt, R. F. Barnes, and P. J. Wangsness. Infrared spectral analysis for evaluation of nutritional components of forage. Factors affecting nutritional value of alfalfa hay. Feeding behavior of ruminants fed forage-based complete rations.

USDA, Regional Pasture Research Laboratory, University Park, Pa.

Breeding--R. R. Hill, Jr., K. T. Leath, R. A. Byers, and others. Effects of the number of parents on performance of synthetic cultivars. Comparison of selection methods for improving resistance to Leptosphaerulina briosiana and Phoma herbarum. Recurrent sib-selection for yield. Recurrent selection for pest resistance.
Pathology--K. T. Leath, D. L. Gustine, and others. Effect of foliar disease on persistence, quality, and yield. Fusarium root rot: stress interactions and host-pathogen relationships. Phytoalexin induction, biosynthesis, and degradation.
Entomology--R. A. Byers and others. Effect of potato leafhopper and alfalfa blotch leafminer on alfalfa yield and quality. Effect of clover root curculio on persistence of alfalfa stands. Recurrent selection for insect resistance.
Nutritive evaluation--G. A. Jung, R. L. Reid (W. Va.), C. F. Gross, W. A. Kendall, and others. Effects of genotypes, season, and fertilizers on mineral accumulation and relation of these to animal feeding quality. Interrelationship between root development and mineral accumulation. Efficiency of mineral uptake.

USDA Beltsville Agricultural Research Center, ARS, Beltsville, Md.

Ruminant nutrition--H. K. Georing. Influence of handling, storage, and processing on feed value of stored forages. Effect of dehydration on nitrogen and dry-matter digestibility.
Plant physiology--N. J. Chatterton and G. E. Carlson. Research on alfalfa is conducted to identify rate limiting growth processes, especially those related to photosynthesis and translocation of assimilates. Specific experiments include infrared gas analyses of CO_2 exchange; $C^{14}O_2$ uptake, translocation and assimilate utilization; adenylate energy change measurements; as well as nutrient uptake and metabolism as related to photosynthesis and translocation.
Breeding--J. H. Elgin, Jr., R. H. Ratcliffe, J. R. Graham, S. A. Ostazeski, and C. D. Foy. Evaluation of anthracnose resistance in field trials on a cooperative nationwide basis. Evaluation of multiple pest resistant populations developed at Beltsville. Continue recurrent selection for resistance to Fusarium oxysporum and Mycoleptodiscus terrestris. Attempt to transfer M. sativa resistance to alfalfa weevil larval feeding found in M. scutellata and

M. rugosa. Begin screening for multiple resistance to anthracnose, bacterial wilt. Fusarium and Mycoleptodiscus using independent culling level technique. Development of tolerance to high levels of aluminum in a high yielding population. Monitoring movement of alfalfa blotch leaf miner and European leaf beetle.

Sainte-Foy Research Station, Agriculture Canada, Quebec

Breeding--R. Michaud and C. Willemot. Development of plant material with more resistance to freezing and greater winterhardiness both through laboratory methods and field testing. Development of plant material resistant to both the root lesion and root knot nematode. Selection methods to increase hybrid vigour in alfalfa.
Pathology--C. Richard and R. Michaud. The succession of the Fusarium root knot organisms as they infect the alfalfa plant. Development of a screening technique to select material resistant to Fusarium root knot and Fusarium wilt. Verify the presence of the Phytophtora megasperma organisms on diseased plants.
Management--J. C. St-Pierre. The economics of using nitrogen on timothy or legumes with timothy in the production of hay.
--R. Drapeau. Evaluation of two seed coating processes with alfalfa.
Bacteriology--L. Bordeleau. Viability and efficiency of alfalfa inoculants sold in Quebec and selection of new strains. Methodology of inoculation. Persistence of Rhizobium in soils using cultivar specific strains. Physiological parameters of free living Rhizobium in relation to their symbiotic activity. Inoculant testing according to norms developed for Plant Products Division by the Sainte-Foy Research Station.
Crop and plant physiology--R. Bolduc, C. Willemot, H. Hope, R. Paquin, C. de Kimpe, G. Mehuys, J. Ziska, C. Richard, J. Santerre, and C. Gagnon. The role played by climate, soil, diseases, and pests in the destruction of alfalfa during the cold season.
--C. Willemot. Changes in lipids during the hardening process of alfalfa.
--H. Hope. Changes in protein synthesis during induction of frost resistance.
--R. Paquin. The metabolism of amino acids during the hardening process.

Laval University--P. Gervais. Effects of seeding alfalfa with and without cover crop and of their dates of harvest on alfalfa yield. Rate of seeding alfalfa in the Quebec region. Determine the optimum fall management for the different climatic zones in Quebec. A study on heights and frequency of cutting.

La Pocatière, Experimental Farm, Agriculture Canada--L. Belzile. Spring and late summer seeded alfalfa. Evaluation of two seed coating processes with alfalfa.

Deschambault Agricultural Research Station, Agriculture Quebec--G. Dupuis. Seeding alfalfa with or without cover crop under eastern Quebec conditions.

St-Hyacinthe Agricultural Research Station, Agriculture Quebec--N. Faust. Evaluation of two seed coating processes with alfalfa.

QUEBEC

Alfalfa screening and regular variety trials are conducted at six locations, namely: Macdonald College, St-Hyacinthe, Lennoxville, Sainte-Foy, LaPocatière, Normandin, Palmarolle (northwestern Quebec).

University of Guelph, Ontario--B. Christie. Variability of temperature response in alfalfa. Selection for proteins, digestibility, and winterhardiness. Inheritance of the resistance to the root knot nematode.

Ottawa Research Station-Agriculture Canada--H. Baenziger. Development of cultivars persistent under the humid and harsh climatic conditions of eastern Canada. Determining effects of Phytophtora and of environment upon survival.
Genetics--L. Dessureaux and H. Baenziger. Studies on methods of utilizing hybrid vigor in breeding programs and development of efficient selection procedures for increased yield.
Entomology--J. C. Guppy and D. G. Harcourt. Evaluation of alfalfa weevil population dynamics and pest management systems.

ONTARIO

Alfalfa screening and regular variety trials are conducted at Ottawa, Ridgetown, Guelph, New Liskeard, Kemptville, Thunder Bay, and Kapuskasing.

Central Alfalfa Improvement Conference Report

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The Fourteenth Central Alfalfa Improvement Conference (CAIC) met at Madison, Wisconsin, July 15 and 16, 1975. The program was designed primarily around field tours of the forage breeding, forage management, and forage variety testing research with special emphasis on the alfalfa juice utilization project. The program also included a discussion by the Nitrogen Company Inc. and the presentation of four research papers.

The Fifteenth CAIC will be held at Ames, Iowa on June 22-23, 1977. The program will include a visit to the North Central Regional Plant Introduction Station to observe the collection of winterhardy alfalfa introductions. Officers for the conference will be: Chairman, D. K. Barnes; Vice Chairman, E. T. Bingham; and Secretary, I. T. Carlson.

A regional research summary was not prepared for the 25th National Alfalfa Improvement Conference because a survey was conducted for the 1975 CAIC and the responses were similar to the Report of the Central Conference in the report of the 24th Alfalfa Improvement Conference.

Western Alfalfa Improvement Conference Report

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The Sixteenth Western Alfalfa Improvement Conference (WAIC) met in Honolulu, Hawaii on June 25, 1975. Discussions were had about defining ecological zones for alfalfa production. A report was made on progress of collecting seed of standard varieties to be used in research studies. Dr. M. H. Schonhorst spoke on "The Arizona Alfalfa Breeding Program".

A regional research summary was not prepared for the 25th National Alfalfa Improvement Conference. The report presented in the 24th Alfalfa Improvement Conference is generally current.

Committee on Standard Tests for Characterizing Disease and Insect Resistance of Alfalfa Varieties

As recommended by the 24th Alfalfa Improvement Conference, this committee 1) reviewed the standard tests bulletin (ARS-NC-19) for changes in scientific names of pests, names of research personnel, check varieties, evaluation procedures, and pest distribution and severity maps; and 2) developed plans for and began collecting foundation seed of the check varieties used for the standard tests. Seed will be stored and distributed to those conducting standard evaluations.

Following review of the standard tests bulletin, the committee acknowledged that changes in research personnel, evaluation procedures, and distribution and severity of pests were taking place constantly and the bulletin needs to be updated periodically. However, because of the relatively recent publication of the bulletin, it was resolved to delay attempts to update it at this time and work toward revision of the bulletin in 1978. Also, present supplies of the bulletin are nearly exhausted and a revision is needed to honor requests.

In regard to collection and storage of seed of check varieties, 10 pounds of foundation seed of 13 of 17 check varieties listed in the standard tests bulletin have been obtained and are stored in a refrigerated seed storage facility at Beltsville, Md. Registered or certified seed have been substituted in the case of three varieties. Seed of all 17 varieties should be available by April 1977. These seed lots will serve as a uniform source for the check varieties. Seed of these varieties will be supplied in amounts not exceeding 20 grams to those conducting evaluations in which the standard checks are needed. At least 220 samples could be distributed of any one variety before restocking would be necessary and, assuming good retention of seed viability in storage, these lots should last for at least 5 years. Using foundation class seed should insure fairly consistent variety performance when changing to a new seed lot. Five experimental lines are also listed as checks in the bulletin. However, due to short supplies of seed they will remain in the custody of the originating station. Requests for seed of the check varieties and the five experimentals should be addressed to J. H. Elgin, Jr., USDA, ARS, Field Crops Laboratory, Bldg. 001, BARC-West, Beltsville, MD 20705.

Recommendations

The committee on Standard Tests for Characterizing Disease and Insect Resistance of Alfalfa Varieties recommends:

1. That in view of the need to update the standard tests bulletin the committee conduct a thorough review of research personnel, check varieties, evaluation procedures, etc., during this next year with the objective of publishing a revised bulletin in 1978.

2. That the use of the word "variety" in the committee name and in the revised bulletin be changed to "cultivar" to conform with accepted terminology.

Respectfully submitted by:

F. I. Frosheiser
K. T. Leath
W. F. Lehman
M. W. Nielson
R. H. Ratcliffe
E. L. Sorensen
D. K. Barnes
J. H. Elgin, Jr., Chm.

Report accepted.

Committee on Gene Nomenclature and Symbolization

It was the responsibility of this committee to coordinate gene nomenclature for alfalfa. In addition to the 56 references on alfalfa gene markers listed in the ARS-USDA Technical Bulletin No. 1370 "An illustrated summary of genetic traits in tetraploid and diploid alfalfa", we recorded 26 additional references. These references are listed below in chronological order.

Since there are less than 100 reprints of the original gene marker bulletin remaining, it was decided to begin a new revision. Dr. J. H. Elgin, Jr. has agreed to co-author the revision with D. K. Barnes. In order to make the new publication as current as possible, please notify either Barnes or Elgin if you have inheritance information on a genetic trait not previously described. The new revision will utilize the system for assigning letter symbols reported in the 24th Alfalfa Improvement Conference report.

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Submitted by: E. T. Bingham
G. R. Buss
M. K. Miller
D. K. Barnes, Chm.

Committee on Variety Certification

This committee was asked to develop a statement on the seriousness of isolation to the production of alfalfa seeds. It was asked to first examine all available evidence on the subject and to also determine what effect the percentage of outcrossed seed would have on varietal performance. Dr. H. E. Gallaway stated (in a letter to Dr. Marion Peterson dated April 14, 1976) that the question of isolation as it relates to the production of alfalfa seed has been discussed at various times by the Alfalfa Improvement Conference as well as the Alfalfa Standards Committee of AOSCA, but both failed in making any changes or corrections as needed. His concern has been shared by many other workers in the field including the chairman of the Alfalfa Seed Standards for AOSCA. In turn, they urged Dr. Gallaway to make a recommendation to the NAIC that this item be placed on the agenda for the 1976 meeting. Thus it seems very desirable for the NAIC at this time to respond to this important request and provide a guideline on recommendations to AOSCA concerning the isolation for Variety Certification. A survey of committee members provided the following information and recommendations: Isolation should be considered as only one of the many problems involved in maintaining varietal integrity. Related problem areas include:

a) Age of stand for seed production
b) Field size
c) Land requirements-cropping history sequence
d) Control of volunteer seedlings
e) Longevity of plants initially established - rate of thinning
f) Genetic variability in the variety itself, particularly for characters that may be vulnerable to attack by diseases or insects present in the seed production fields.
g) Minimizing mechanical contamination from harvesting equipment through processing.

Many of the above factors are predictable and controllable. Others are not. For example, one way to control some of these hazards is to limit the age of seed fields for certification, especially stock seed fields. The idea of grouping varieties together should be reconsidered as one way to ease isolation problems. Available data show that alfalfa pollen can be carried some distance by honeybees and other pollinators. However, scientific research data on pollen contamination and the seriousness of various contamination levels on variety performance has not been considered when establishing certification standards. We feel it is now time to determine if present certification standards are both valid and practical. If critical research data are not now available the necessary research studies should be designed and conducted as soon as possible by members of the NAIC. In summary, the following are our guidelines when considering new research or certification standards:

a) For certified seed fields: certification standards should stress the integrity of phenotype (varietal performance) which is of paramount interest to farmers. Continued studies are needed to weigh the effect of various factors on 'varietal performance', such as age of stand for seed production, control of volunteer seedlings, and isolation distance.

b) For Foundation seed and Breeder seed fields: certification standards should emphasize maintaining varietal integrity (genotype integrity). Evidence seems to indicate that limiting the age of stand for the production of stock seed (foundation) may be as important as isolation restrictions.

We recommend that: (1) the coming variety certification committee continue to gather all past, present, and current data on the isolation distance in relation to the percentage of outcross in the production of certified alfalfa seed and age of seed production field in relation to genetic shift and varietal performance. (2) The committee should consist of members who are currently working in this field. In addition to members of the seed industry, the committee should include both Canadian and American and University and ARS personnel. (3) The committee should present their recommendations on alfalfa certification standards to the conference members two months prior to the 1978 meeting.

Paul Sun (Chairman)
V. L. Marble
D. F. Beard
E. L. Granstaff
R. W. Cleveland, Jr.
D. W. Brown

Report of the Committee on New Cultivar Descriptions

This report attempts to list and briefly describe alfalfa cultivars which have been developed and released since the last report was submitted to this conference in 1974. There are two tables listing those cultivars released and certified in the United States and cultivars licensed for production in Canada.

If additional information on individual cultivars is desired, the breeder or applicant of the cultivar should be contacted.

Voluntary registration of all new cultivars with the Crop Science Society is strongly encouraged. This provides readily accessible information which describes the cultivar's principal characteristics, thus enhancing the matching of specific cultivars or genotypes with potential areas of use and specific problems found in that area. For information on how to register alfalfa cultivars in Crop Science, see pages 63 and 64 in the report of the 24th Alfalfa Improvement Conference.

Information summarized in Tables 1 and 2 was collected and respectfully submitted by the following members of this committee:

W. R. Childers
R. V. Frakes
J. L. Mings
M. S. Offutt
J. B. Washko
D. A. Miller (Chairman)

Secretary's Note

During the business meeting, a motion was made and passed that in the future the New Cultivar Descriptions Committee would be eliminated and that the secretary would be instructed to routinely include descriptions of new varieties favorably reviewed and described by the National Alfalfa Variety Review Board in the Alfalfa Improvement Conference Report. A listing of varieties licensed in Canada will also be included.

TABLE 1. ALFALFA CULTIVARS APPROVED FOR CERTIFICATION, DEVELOPED OR INTRODUCED FOR USE IN U.S. SINCE 1974

Name of cult. and year of certification	Exp. design.	Certification: Applicant	Certification: Developers	Origin and/or breed. proced.	Probable area of adaptation	First year of commercial distribution
Apollo 1975	NAPB44	NAPB	J.B. Moutray	Three cycles of recurrent sel. for Phytophthora res., Bact. wilt res., Mod. tolerance to pea aphid	Midwest to Southern Canada	1975
Ardiente 1975	A-21	Ferry-Morse Seed Co.	E. H. Beyer Tony Wilson	Non-dormant, res. downy mildew and stemphylium leafspot 20 clone syn.	Southern Calif.	1977
AS-13R 1975	AS-13R	Ferry-Morse Seed Co.	E. H. Beyer Tony Wilson	Intermed. dormancy, res. to phytophthora, stemphyllium leafspot, downy mildew, stem nematode, and spotted alfalfa aphid. 81 clone syn.	San Joaquin Valley, Calif.	1975
AS-49R 1975	AS-49R	Ferry-Morse Seed Co.	E. H. Beyer Tony Wilson	Semi-dormant, res. to phytophthora, and spotted alfalfa aphid. 31 clone syn.	Sacramento to No. San Joaquin Valleys, Calif.	1976
Chimo 1972	21	L. Teweles Seed Co.	W. H. Davis	Semi-dormant, res. to bact. wilt, Mod. res. leaf spotting, suscep. to leafhopper. 79 clone syn, source A and 50 clone source B crossing.	N.C. States and Canada	Not designated
Citation 1974	RP-103	NAPB	J.B. Moutray	Seven clone syn. res. to bact. wilt, pea aphid and winter hardy	Upper N.C. U.S. and Canada	1974
Deseret (Kayseri) 1974	U-5045	ARS-USDA-Utah Agr. Exp. Sta.	M.W. Pedersen	Two gen. recurrent sel. for stem nematodes res. from 150 clones, Res. bact. wilt, lodging.	Western U.S.	1976
G777 1972	KO-8	Northrup King and Co.	Northrup King personnel	Recurrent sel. with many clones, Mod. res. bact wilt, leafhopper.	Upper Midwest	1973
Honeoye 1975	Syn L	Cornell Univ.	R.P. Murphy C.C. Lowe	Three cycles rec.sel. for vigor, regrowth, res. bact. wilt.	New York	1976
Lew 1974	Az-SNR	Univ. of Ariz.	M.H. Schonhorst R.K. Thompson L.K. Hunt	100 clone syn, res. stem nematode, rod-shaped virus, and pea streak virus.	Desert area of Ariz.	1977
Marathon 1974	MW66-22 K1-1	Northrup King and Co.	Northrup King personnel	BC with 50 clones. Mod.res. bact. wilt. Semi-dormant.	Central & N.E. U.S.	1975

TABLE 1. ALFALFA CULTIVARS APPROVED FOR CERTIFICATION, DEVELOPED OR INTRODUCED FOR USE IN U.S. SINCE 1974--continued

Name of cult. and year of certification	Exp. design.	Certification		Origin and/or breed. proced.	Probable area of adaptation	First year of commercial distribution
		Applicant	Developers			
NCW 20 1975	NCW 20	ARS, USDA, NCSU Okla State U.	T.H. Busbice C.H. Hanson	Six gen. rec.sel. Inter. fall dorm., High tol. alfalfa weevil, Res. anthracnose and mod. res. pea aphid, Suscep. spotted alf. aphid and bact. wilt	Atlantic westward to Okla.	1977
Nugget 1974	RP/DC-5	NAPB	J.R. Thomas J.B. Moutray	Rec.sel. 4 clones Res. bact. wilt and Mod. res. pea aphid	Midwest to So. Canada	1974
Pacer 1975	FN244	Land O'Lakes, Inc.	D.E. Brown R.R. Kalton	Eight clone syn. Res. to pea aphid, bact. wlit, phytophthora root rot, and mod. res. to leaf and stem diseases.	Kansas, Missouri, Illinois, and northward to N. Dakota, northern Minnesota, Wisconsin and eastward.	1976
Polar I 1974	MW68-1 K1-8	Northrup, King and Co.	Northrup-King personnel	Nine clone syn. Mod.fall dormancy, Res. bact. wilt	Midwest to So. Canada	1975
Saranac AR 1975	Anthrac res. Saranac	Cornell Univ.	R.P. Murphy C.C. Lowe	One cycle rec.sel. from GP 18 Belts2-an4 Res. anthracnose and bact. wilt	Same as Saranac	1976
Spredor 1974	MW67-2	Northrup, King and Co.	Northrup King personnel	Three cycles and sel. for res. to bact.wilt and spreading char.	Midwestern U.S. and So. Canada	1975
U C Cargo 1975	UC 66	Univ. of Calif.	W.F. Lehman E.H. Sanford	Sixth cycle sel. for good winter product. Res. soil salinity, spotted alf. aphid, and mod.res. to phytophthora and pea aphid.	Desert area of Calif.	1975
Valor 1974	R.S. 80	Land O'Lakes, Inc.	R.R. Kalton, D.E. Brown	Nine clone syn. Res. to bact. wilt and pae aphid Mod.res. to leaf and stem diseases and potato leafhopper	Same areas where Vernal performs well	1974
Vista 1975	68-1	Cal/West Seeds	I.J. Johnson	Syn 19 clones Similar to Saranac and not res. to spotted alf. aphid or pea aphid	Midwest to Pa.	1976
WL219 1975	72GR-1 Exp. 219	Waterman-Loomis Co.	D.F. Beard I.I. Kawaguchi D.N. Clary	27 clone syn. Hardy and rapid regrowth, Res. bact.wilt. Tol. to Anthracnose, phytophthora, Fusarium, pea and spotted aphid	Midwest	1976
WL310 1974	72MW-SNR-1	Waterman-Loomis Co.	I.I. Kawaguchi D.F. Beard	175 clones syn. Res. to bact.wilt, stem nematode and spotted alf. aphid	Midwestern U.S.	1975

TABLE 1. ALFALFA CULTIVARS APPROVED FOR CERTIFICATION, DEVELOPED OR INTRODUCED FOR USE IN U.S. SINCE 1974--continued

Name of cult. and year of certification	Exp. design.	Certification: Applicant	Certification: Developers	Origin and/or breed. proced.	Probable area of adaptation	First year of commercial distribution
WL311 1974	70 T3 72 WR ANR-1	Waterman-Loomis Co.	D.N. Clay	Syn. Semi-dormant Fast recovery, res. to bact.wilt, anthracnose, spotted aphid, and mod. res. to pea aphid	Eastern U.S. & Midwest	1975
WL318 1974	Ca 193-97	"	D.F. Beard I.I. Kawaguchi	Syn. semi-dormant, Fast recovery, res. to bact.wilt, mod. res. to phytophthora, anthracnose, fusarium wilt and res. to spotted and pea aphid.	Midwestern U.S.	1975
WL450 1972	Ca 896-25	"	D.N. Clay	Syn. 31 clone. Res. to spotted aphid, downy mildew, and mod.res. to S.Anthracnose, leaf-spot and pea aphid.	S.W. U.S.	1974
WL451 1972	CX 499-EDR	"	I.I. Kawaguchi D.F. Beard	Syn. Res. spotted aphid and mod.res. to bact. wilt, downy mildew and pea aphid.	S.W. U.S.	1974
WL501-R 1972	CX-497	"	I.I. Kawaguchi D.F. Beard	Syn. Res. spotted and pea aphid and mod.res. to pea aphid, downy mildew, S. Anthracnose, and bact.wilt.	S.W. U.S.	1974
WL600 1972	Ca 916-17-209	Waterman-Loomis Co.	I.I. Kawaguchi D.F. Beard	Syn. 32 clones Res. spotted and pea aphid, and mod.res. to S.Anthracnose and downy mildew.	S.W. U.S.	1974
167 1974	Syn69-10	Cal/West Seeds	I.I. Johnson	Cycle 1 of rec.sel. Res. spotted and pea aphids, and tol. to phytophthora, leaf-spots, downy mildew and stem nematodes.	W. U.S. in poorly-drained soils	1974
521 1975	69E-1 & JE	Pioneer Hi-Bred Int., Inc.	Pioneer Hi-Bred personnel	Syn. 18 clone. Res. bact.wilt and spotted aphid.	Where 520 and Vernal are grown	1976
530 1972	69B-1	Arnold Thomas Seed Ser.	J.W. Miller H.L. Carnahan	BC of 24 clones Res. bact.wilt, spotted aphid, Leptosphaeruliva and mod.res. downy mildew and pea aphid.	Midwest U.S.	1973
572 1975	72N-1 and MN	Pioneer Hi-Bred Int., Inc.	M.K. Miller	Syn 34 clones, Res. spotted and pea aphid, downy mildew and some tol. phytoph-thora.	Non-dormant areas of U.S.	1976

TABLE 2. ALFALFA CULTIVARS LICENSED FOR PRODUCTION IN CANADA SINCE 1974.

Name of cult. and year of certification	Exp. design.	Certification		Origin and/or breed. proced.	Probable area of adaptation	First year of commercial distribution
		Applicant	Developers			
Anik 1975	-	Canada Dept. of Ag. Res. Sta. Beaverlodge Alb., Can.	P. Pankin B. Siemers	Semi-procumbent, Some tolerance to *Plenodomus meliloti*, Suscep. to bact. wilt.	North of latitude 57°N for grazing	1975
Arnim 1966	-	Pioneer Hi-Bred Int., Inc.	Countess Von Arnim	Winter hardy, Suscep. to bact. wilt, spotted alfalfa aphid, green pea aphid	Wet soils in upper Midwest	1966
Trek 1975	-	Canada Dept. of Ag. Res. Sta. Lethbridge, Alb., Can.	M. R. Hanna	Resistant to bact. wilt, stem nematodes	Irrigates areas of Southern Alb. for hay	1975

Report of Standardized Cultivar Description Committee

A committee established in 1975 was given the assignment to:

1. Establish a uniform description terminology for alfalfa cultivars.
2. Try to develop a single universal computer system for the description.
3. Describe and list all cultivars.
4. Where possible assign cultivars to individuals to work out missing information for descriptions.
5. Classify listed cultivars into major categories of economic importance.

The committee recommends that a description of cultivars should include the unabbreviated name, originator, literature reference, year first available and definitive information on dormancy and as many as possible pest reactions. It should also include a description of the breeding procedure and genetic material that constituted the cultivars.

Standardized tests have been developed by researchers for some characteristics and have been or are being used to characterize alfalfa cultivars. Information from these types of tests with a comparison with check cultivars will be the basis for the description of pest and dormancy reaction.

A computer system has been tentatively outlined to include fields for cultivar name, originator, literature reference, year available, clone or population numbers, breeding procedure, dormancy rating, seed increase information, and rating for as many pests as available.

A list of cultivars has been compiled to include as many as can be obtained world wide, but only those cultivars which have been reviewed by the National Alfalfa Variety Board will be described. The list has approximately 155 U.S. and Canadian cultivars and an additional 115 from other countries. The computer list as set up would then have all cultivar names and their origin plus a description as outlined above for reviewed cultivars. This description will take the equivalent of 3 punch cards. An additional narrative description will follow on those cultivars that have been reviewed. Everything will be maintained on tape.

The committee recommends that a single source or location be set up to provide the computer mechanics that will be required; and that retrieval of information be on a scheduled quarterly or semi-annual basis. The committee also recommends that the 5th objective as listed be dropped because there is not enough information available on cultivars being used in the U.S.

The committee recommends that the remaining objectives be pursued to completion and that a publication be prepared to show the results of the computer set up.

Submitted by:

D. K. Barnes
Kenneth Evans
D. H. Heinricks
R. R. Hill, Jr.
Jonas Miller
R. N. Peaden, Chairman

Report accepted

Report of the Committee on Available Breeding Lines of Alfalfa

The committee canvassed the experiment stations in the U. S. and Canada and seed industry representatives with alfalfa breeding programs for additions to the lists included in previous reports. The new entries are as follows:

State/Province	Contact	Official Release	Stock	Description
NC-83 Nebraska Minnesota Illinois Indiana Iowa South Dakota Wisconsin Kansas USDA/ARS Alaska Land O'Lakes, Inc. Arnold-Thomas Seed Service	W.R.Kehr or Regional Plant Introduction Sta., Ames, Iowa 50010	NC-83-1	Seed	A broad-based population consisting of 94 alfalfa cultivars adapted to northern alfalfa growing areas and 36 foreign plant introductions. Population should serve as a source of multiple-pest resistance plus desirable agronomic traits. (Crop Sci. 15:604-605, 1975)
NC-83 Nebraska Minnesota Illinois Indiana Iowa South Dakota Wisconsin Kansas USDA/ARS Alaska Land O'Lakes,Inc. Arnold-Thomas Seed Service	W.R.Kehr or Regional Plant Introduction Sta., Ames,Iowa 50010	NC-83-2	Seed	A broad-based population consisting of 63 cultivars, experimental synthetics, breeding populations and released germplasm adapted to the southern part of the North Central region and 45 plant introductions. Population should serve as a source of multiple-pest resistance and desirable agronomic traits. (Crop Sci. 15:604-605, 1975)
Colorado	C.E.Townsend	C-3	Seed	Cycle 2 seed of a population consisting of 63 germplasm sources which possess characteristics of value in a dryland alfalfa breeding program. (Crop Sci. 16:446, 1976)

State/Province	Contact	Official Release	Stock	Description
Illinois	D. A. Miller	Ill 76-1	Seed	Derived from random intercrossing of 2 clones selected for rapid growth, little fall dormancy and moderate resistance to alfalfa weevil, combined with high seed yield.
Illinois	D. A. Miller	Ill WE-47	Seed	Cycle 3 of a recurrent selection program derived from 12 clones. Selected for good resistance to alfalfa weevil, high protein, slight fall dormancy and high seed yield.
Arizona	M.H.Schonhorst	PA-1	Seed	Derived from recurrent selection for pea aphid and spotted alfalfa aphid resistance in 15 superior non-hardy cultivars and experimentals. Very high level of resistance to pea aphid.
Maryland USDA/ARS	J. H. Elgin, Jr.	DA-1 DA-2	Seed	DA-1 traces to Moapa, Beltsville. 2-AN_4W_2, and ARC-$Sb_3W_2F_1$. DA-2 traces to Florida 66, Beltsville. 2-AN_4W_2, and ARC-$Sb_3W_2F_1$. Both have moderate resistance to anthracnose and bacterial wilt; Susceptible to Phytophthora root rot. DA-1 is highly resistant and DA-2 moderately resistant to pea aphid. Both have low levels of resistance to biotype H of spotted alfalfa aphid.

State/Province	Contact	Official Release	Stock	Description
USDA/ARS Kansas Minnesota Nebraska Nevada Washington	D. K. Barnes	BIC-5	Seed	BIC-5 is a broad-based population consisting of 75 cultivars, experimental synthetics and other germplasm representing a complete array of non-hardy and hardy alfalfa sources in one germplasm pool. BIC-5WH represents 2000 out of 5000 plants of BIC-5 which overwintered at St. Paul, Minnesota and were intercrossed.
		BIC-5 Sub-populations		Sub-populations resulting in selection for pest resistance in BIC-5.
		BIC-5-AN		Southern Anthracnose
		BIC-5-BW		Bacterial Wilt
		BIC-5-CLS		Common leafspot
		BIC-5-FLS		Field leafspots
		BIC-5-PRR		Phytophthora root-rot
		BIC-5-PA		Pea aphid
		BIC-5-PLH		Potato leaf hopper
		BIC-5-SAA		Spotted leaf aphid
		BIC-5-SN		Stem nematode
		BIC-6		Intercross of the 9 sub-populations in BIC-5 and BIC-5WH
		BIC-6WH		
		BIC-7		Syn 2 generation
		BIC-7WH		of BIC-6 and BIC-6WH
Wisconsin	E. T. Bingham	W70-22	Seed	Diploid population produced by crossing 2x haploids derived from cultivated alfalfa with 2x *M. falcata*
		W71-42	Seed	Tetraploid population with same cytoplasm and about 75% *M. falcata* and 50% *M. sativa* genes in common with W70-22 release.
		W71-47	Seed	Tetraploid population produced by crossing nine *M. falcata* plants from PI 231731 with 3 *M. sativa* plants from 'Saranac'

State/Province	Contact	Official Release	Stock	Description
Wisconsin		W72-48	Seed	Contains all germplasm from W71-42 release plus germplasm from M. falcata representing 5 different regions in USSR. (Crop Sci. 15:889, 1975)

The report does not include official variety releases and plant introductions because these are published elsewhere. Eight official releases of germplasm were made during the two year period.

The committee asked those contacted for either positive or negative replies on such information as releases made, distribution of seed or requests for these or previous releases, requests they made for released material and use to which releases were put. The response to these requests was extremely poor except for the industry breeders who gave a 90% response to all questions.

A total of 101 requests were received for released germplasm by the respondents and 56 respondents requested germplasm releases. The principal uses made of requested germplasm was as a source of pest resistance, as a check variety in pest resistance evaluation, and for incorporation into present breeding material for future use. If our survey has any degree of accuracy, industry breeders appear to utilize germplasm releases more readily than public breeders. There still appears to be considerable merit in evaluating germplasm releases for gene frequencies for resistance to the principal pests and for other desirable characteristics such as dormancy and winterhardiness.

Germplasm releases are being used rather extensively not only in the U.S. and Canada but in other parts of the world. Many requests are received from foreign workers for information on available germplasm. It is difficult to give these requests the attention they deserve because our release documentation is contained in a series of reports. There would be merit in a consolidation of information on releases as a handy reference for such requests.

The committee recommends consolidating into one publication all information on breeding lines which have been officially released to date. The Chairman has taken the initial step in accomplishing this by arranging for publication as an ARS-Western Region special publication.

The committee recommends continuation of the function of the Committee on Available Breeding Lines of Alfalfa.

Respectfully submitted by:

D. H. Heinrichs
Ike I. Kawaguchi
E. S. Horner
M. H. Schonhorst
Bill Melton
O. J. Hunt, Chairman

1976
Preservation of Germplasm
Committee Report

The Committee noted the 1974 Report which brings up to date the status of germplasm maintenance at the National Seed Storage Laboratory at Fort Collins, Colorado and the Plant Introduction Station at Ames, Iowa. Dr. Skrdla at Ames has approximately 1000 accessions on hand and feels that the cooperative increase and maintenance program initiated in 1970 and 1972 by this Committee is adequate for his purposes. Dr. Skrdla at this time needs from scientists who are evaluating germplasm accessions information on which are valuable and should be increased. A summary of seed distribution by Skrdla follows:

	Number of packets
1970	1424
1971	330
1972	1353
1973	1311
1974	177
1975	1430
Total	6025
Average per year	1004

In line with the recommendations from the 1974 Report an alfalfa researcher from Canada, B. P. Goplen, has been named to the Committee. In addition, Roland Loiselle, Canada Department of Agriculture, Central Office for the Plant Gene Resources of Canada, has cooperated with the Committee. He reports that from a survey in 1971 over 4000 stocks of Medicagos were maintained by 18 individual plant breeders and other plant scientists in Canada. Information of value to scientists exists in a computer program on 495 of these stocks held by eight individuals (466 of these are held by K. Lesins, Department of Genetics, The University of Alberta). Mr. Loiselle states: "I am willing to cooperate in any program that would promote the exchange of information and material between the United States and Canada."

Information on the Lesins Collection has come to the Committee from Loiselle, Goplen and Skrdla. The Collection exists as seed in duplicate. One set is in a new seed storage facility with controlled environment at the Genetics Research Farm at Ellerslie (15 miles from the University) and the other is in the Department of Genetics at the University. The Collection consists of approximately 2900 Medicago Accessions. Only about 500 are perennial. The vast majority are annuals and this Committee has excluded these from their activity in the past. However, we feel that some of these may be of interest as sources of insect and disease resistance for transfer to perennial sorts. Dr. Lesins seems most concerned at this time about the maintenance of the annual sorts. He is still working on the Collection. He states that annuals need evaluation and increase under more southerly conditions.

Several matters remain before the Committee.

We have raised the question of maintenance and storage of domestic germplasm releases and available breeding lines with the Committee on Available Breeding Lines of Alfalfa. We feel that many of these represent valuable germplasm and should be maintained in our germplasm resources of alfalfa.

We have continued our interest in a comprehensive exchange of germplasm with the USSR and have worked with Dr. Charles F. Lewis of ARS, USDA. Specific requests for Russian materials should be submitted through Mr. H. L. Hyland. Several alfalfas have been received recently by him from the USSR. The Committee feels that a joint collection trip in both countries by USSR and US scientists should be developed for perennial legumes, especially the Medicagos and Trifoliums.

Utilization of plant introductions by incorporating them into active germplasm pools remains a matter before the Committee. A paper by Barnes, et al is in press entitled Alfalfa Germplasm in the United States: its genetic vulnerability, use, improvement and maintenance. The Committee has reviewed excerpts from this paper which recommends the development of active germplasm pools at three locations. As expected some members feel that there should be as many as seven as suggested by Hanson et al in 1972 in the Journal of Environmental Quality.

We recommend that the Committee be continued and directed to hold a two or three-day meeting at Ames or Fort Collins in order to consider two matters:

1. A proposal for the development of active germplasm pools as proposed by Hanson et al and Barnes et al, and

2. A proposal for a joint collection trip in the USSR and the US for perennial legumes.

This meeting should be held in time to develop specific proposals before the next Alfalfa Improvement Conference.

Submitted by:

R. J. Buker
T. H. Busbice
B. P. Goplen
R. R. Kalton
M. D. Rumbaugh
W. H. Skrdla
R. P. Murphy, Chairman

Committee on Potential Research Problems Associated with New Uses of Alfalfa such as Protein Extraction

This Committee was established in 1975 with the following duties:

1. Review work at various institutions on alfalfa protein extraction and utilization as well as other new uses.
2. Study available methods and procedures to see if there are problems that the NAIC should consider.
3. Review Food and Drug Administration regulations in regards to new cultivars and alfalfa protein.
4. Prepare report on Committee activities.

Committee responses were obtained by correspondence:

1. Protein extraction and other new uses. The primary work in the U.S. on the use of expressed protein (leaf protein concentrate-LPC) from alfalfa as a source of protein for human food has been at the USDA Western Regional Research Center, Berkeley, CA. The University of Wisconsin has a team of researchers developing a field machine for a "1-pass" system of expressing protein juice from alfalfa by rupturing the cells and separating the juice from the fibrous material. Other universities, including Cornell, Kansas State, Louisiana State, Massachusetts, Michigan State, Nebraska, Ohio State, Purdue, and Tennessee have projects underway on protein extraction and evaluation of protein quality of LPC by chemical methods or actual feeding trials with livestock.

Production scale plants for LPC production are operating in Denmark, France, and Hungary. The greatest concentration of research and development activity is in Great Britain where a number of private and public organizations have pilot plants. The following areas of research are common to many countries: (a) extraction methods, (b) assessment of economic viability, and (c) LPC production for human consumption. The immediate stimulus for LPC production differs in various nations, but there are four general groups:

(a) Maintaining and extending the economic viability of established forage dehydrating industries, e.g., Canada, France, Germany, Great Britain, New Zealand, and the United States.
(b) The production of a LPC for animal feeds to alleviate dependence upon imported protein supplements, e.g., Great Britain, Hungary, and New Zealand.
(c) Availability of low-cost protein supplements to alleviate acute protein deficiency in human populations, e.g., India, Mexico, and Pakistan.
(d) Manufacturers of processing equipment, e.g., Sweden.

The development of a viable LPC industry will depend upon favorable economic circumstances and a concerted effort in product quality and market development. The development of processes for the utilization of LPC by-products, primarily the whey fraction, is needed. Further studies on physiological and management factors affecting the production and release of protein, and the development of alfalfa cultivars particularly suited for LPC production have been suggested.

Recent studies have indicated that alfalfa meal has an effect in decreasing elevated plasma cholesterol levels in primate species. Other studies have indicated that alfalfa may have an influence upon the metabolism of chemical carcinogens.

2. Methods. An exhaustive study of the available methods and procedures has not been undertaken. It is suggested that the preparation of a bibliography on protein concentrate research and development, applicable to alfalfa, be considered by NAIC.

3. Regulations. Alfalfa, as a natural food ingredient, is on the list of food additives generally regarded as safe (GRAS or GRAS listing) by the Food and Drug Administration (FDA). Alfalfa, as an extractive, is found under the general GRAS listing of essential oils, oleoresins, and natural extractives. In addition, alfalfa herb and seed are separately listed under spices and other natural seasonings and flavorings. The public has also accepted alfalfa in the form of sprouts. It is expected that FDA approval for edible protein from alfalfa can be obtained by means of a GRAS affirmation statement, rather than through a food additive petition. Although prior history of safe use will be taken into account in the FDA evaluation of alfalfa protein isolate, the product will have to satisfy certain FDA requirements. The protein concentrate will need to be submitted to chemical and microbiological evaluation and animal feeding studies to assure that no toxic ingredients are introduced and to relate the protein quality to other available sources of protein.

In Canada, the Production and Marketing Branch of the Agriculture Department is responsible for the regulations of ingredients in livestock feeds. The Feeds Act and Regulations include a list of acceptable ingredients. At the present time, LPC is not on this list because no one has requested authorization to include LPC in livestock feeds. The list can be amended to include new products and at the time of amendment, regulations on use of the new product are formulated to insure that feeds are safe and effective.

Regulation of foods for human consumption is the responsibility of the Foods Directorate of Health and Welfare of Canada. There are presently no regulations covering LPC, but if it were marketed in the future, it would probably be regulated in a similar manner to the other plant proteins such as soybean and rape seed proteins.

Submitted by: R. F. Barnes, Chairman
E. M. Bickoff
R. E. Howarth
W. R. Kehr
R. L. Ogen
Dale Smith
M. B. Tesar

Secretary's Report on Current Public Law 480 Research

The PL-480 program is funded with non-convertible U.S.-owned foreign currencies derived mainly from the sale of U.S. farm products. ARS represents all U.S. Department of Agriculture agencies. The International Programs Division of ARS serves as administrator through offices in Hyattsville, Maryland, Rome, Italy and New Delhi, India. Program activities fall into the general areas of agricultural research, forestry research and agricultural economic research. The overseas research is meant to complement and not duplicate domestic research. Any subject matter area in which ARS is authorized to conduct research is eligible for special currency funding. Each program has a principal scientist on location and a cooperating scientist in ARS. Since the beginning of the program in 1958 through 1975, 1640 research agreements have been negotiated. Eight of the projects have been concerned with alfalfa improvement and utilization. Titles of these projects are listed below:

1. Investigation of the nature of the estrogen-inhibiting factors present in alfalfa and other forages, to provide a basis for improved utilization of dehydrated forages (UR-A10-(10)-60 (FG-IS-245) Hebrew University, Jerusalem, Israel - completed 1-14-72.

2. Chemical and biological studies of the saponins of alfalfa, to provide information basic to optimum utilization of alfalfa meal (UR-A10-(10)-83 (FG-IS-246) Hebrew University, Rehovoth, Israel - completed 1-10-72.

3. Screening of alfalfa lines for resistance to verticillium wilt. (E15-CR-6 (FG-It-118) University of Perugia, Perugia, Italy - Completed 4-17-67.

4. Separation, determination, and characterization of non-tocopherol reducing substances in alfalfa, to provide information of value for improving the stability, and thus the utilization of dehydrated alfalfa. (UR-E15-(10)-17 (FG-It-127) Stazione Sperimentale de Praticoltura, Lodi, Milan, Italy - Completed 4-26-68.

5. Investigations of the carbohydrase enzyme systems of alfalfa and their use in structural analysis of alfalfa polysaccharides, to provide information necessary for development of improved processed alfalfa products. (UR-E29-(10)-52 (FG-UK-133) University of Edinburgh, Edinburgh, Scotland - Completed 5-31-67.

6. Development of varieties of berseem, Persian clover and lucerne for increased production. (PK-ARS-48 (N) (FG-Pa-253) Punjab Agricultural Research Institute, Lyallpur, Pakistan - Currently in progress.

7. Use of traits Medicago (M. sativa, M. falcata L., and M. media Mart.) in the creation of more rational and productive varieties of alfalfa. (YO-ARS-33-JB-24) Institute of Agricultural Research, Novi Sad, Yugoslavia - Currently in progress.

8. Genetical studies on cytoplasmic male sterility and heterosis in Medicago sativa L. and selection of germplasm sources suitable for hybrid breeding. (PL-ARS-60 (FG-Po-337) (JB-2) Institute of Plant Breeding and Acclimatization, Radzikow, Poland - Currently in progress.

Secretary's Note: Dr. Zygmunt Staszewski, principal scientist on the project attended the Alfalfa Improvement Conference and presented a brief discussion of results to date. Evidence suggests the existence of a second system of cytoplasmic male sterility which is different than the one described in the United States.

Resolutions Committee Report

The 25th National Alfalfa Conference in session at Cornell University, Ithaca, New York on July 13-15, 1976 recommends adoption of the following resolutions:

Be it resolved that:

1. We express our sincere appreciation to the administration at Cornell University, to the Agricultural Experiment Station staff, and the Agricultural Extension Service staff for providing the excellent facilities for holding the meetings and tours and for the time they spent in making local arrangements for the conference.

2. We express our appreciation to the various seed industries for providing the courtesy luncheon to those in attendance at this conference.

3. We express our appreciation to the Executive Committee of the 25th Conference for their effort in organizing an excellent program of subject matter of special interest to those conducting research in the many disciplines related to alfalfa.

4. Inasmuch as this is the 25th Anniversary Conference, we wish to express our special thanks to Professor R. A. Brink, emeritus, University of Wisconsin for his excellent and noteworthy address related to conserving our soil as it influences the approaching world-wide scarcity of food. It is noted that he was a member of the first conference and we appreciate his consenting to speak at this special anniversary conference. We also wish to express our appreciation to Dr. C. H. Hanson, retired, USDA, for reviewing the history of the National Alfalfa Improvement Conference. We wish to thank the Northeast seedsmen for providing travel funds for the special speakers.

5. We recommend that the National Alfalfa Improvement Conference continue to include a representative from the Forage Insect Research Conference to help determine the time, location, and program of future meetings.

Respectfully submitted:

V. L. Marble
D. A. Miller
W. H. Skrdla, Chairman

Nominations Committee Report

The nominations committee consisted of the immediate past chairman of the three regional alfalfa improvement conferences (B. A. Melton, D. A. Miller, and R. T. Sherwood) and a representative from Canada (D. H. Heinrichs). Each member nominated three or more names for consideration. The Alfalfa Improvement Conference secretary served as non-voting chairman of the committee. The committee's recommendation for chairman of the twenty-sixth Alfalfa Improvement Conference was Dr. M. D. Rumbaugh, Professor, South Dakota State University. A unanimous ballot was cast for Mel Rumbaugh.

Mr. Jack L. Mings, Plant Breeder, Northrup, King & Co., Washington, Iowa, was elected by industry to serve as its representative on the Executive Committee of the 26th Alfalfa Improvement Conference.

Plans for 1978 National Alfalfa Improvement Conference

The committee to determine the location of the 1978 conference consisted of:

B. P. Goplen - Canada
D. F. Beard - U.S.A.
W. R. Kehr, Chairman
George R. Manglitz, representing Entomologists

After reviewing locations of the previous 25 conferences, it was determined that the Central Region should host the 1978 Conference to maintain the rotation among regions that has developed in recent years. Six states in this region have not previously hosted this conference. One of these, South Dakota, has extended a written invitation to hold the 1978 N.A.I.C. at Brookings. Accordingly, the committee unanimously recommended acceptance of this invitation to meet at Brookings in 1978.

A unanimous ballot was cast for the 1978 meetings to be held at Brookings, South Dakota.

Secretary's Report

Following the 1974 meetings a surplus of registration monies was transferred from the University of Arizona to the N.A.I.C. Secretary. This was the first time that the N.A.I.C. has had a treasury. A 5-3/4% savings account was opened in the name of the National Alfalfa Improvement Conference, which is now listed as a non-profit organization. The account is in the Twin City Federal Savings and Loan, Roseville, MN 55113. Either the conference chairman or secretary can withdraw money from the account. Transactions to date include:

Original deposit (2-7-75)	$582.48
Interest (6-30-76)	44.00
Pre-Conference mailings	-62.55
Conference programs	-185.65
Total available (8-16-76)	$378.28

During the last six months I have attempted to up-date the conference mailing list. Information was obtained on addresses, activity interests, and telephone numbers. Based on the frequency that address information is requested by conference members, I would like to suggest that the conference use some of its treasury to prepare a directory of alfalfa researchers. A motion was made, seconded and passed authorizing preparation of a directory to be prepared and sent to all members.

This year camera copy paper was supplied to all speakers and committee chairmen for use when they prepared their reports. The results have been very satisfying because the paper summaries generally have been improved by being more uniform in length and more concisely written than they were at the last conference. These improvements, plus the reduction of typing required to prepare the conference report, should reduce the time required until it is available.

I have enjoyed working with Marion Pedersen and other members of the 25th Alfalfa Improvement Conference during the last two years. I am looking forward to working with members of the 26th Alfalfa Improvement Conference. If there are suggestions as to how we can improve the Alfalfa Improvement Conference, please contact either myself or the chairman.

Respectfully submitted:

D. K. Barnes

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Distribution of Conference Report

The conference report is sent to all those registered at the 25th Alfalfa Improvement Conference. It will also be sent to all those not attending the conference, but who requested that they be placed on the Alfalfa Improvement Conference mailing list. The report is also sent to libraries that have requested copies of previous reports. In order for research leaders to identify scientists and libraries who should be added to our mailing list, a complete listing of scientists and libraries is provided for your information. If you are aware of new names that should be added to the Alfalfa Improvement Conference directory or if you have a change of address, please send the Membership Questionnaire form at the back of this report to the conference secretary.

Libraries

University of California, Berkeley, CA 94720
University of California, Davis, CA 95616
Colorado State University, Fort Collins, CO 80521
Dept. of Genetics, Ag. Exp. Sta., New Haven, CT 06504
Hume Library Federal Docs., Institute of Food & Agri. Sci., University of Florida, Gainsville, FL 32611
University of Hawaii, Honolulu, Hawaii 96822
John Deere & Co., Moline, IL 61265
University of Illinois, Urbana, IL 61801
Indiana State Library, 140 N. Senate Ave., Indianapolis, IN 46204
Iowa State University, Ames, IA 50010
Enoch Pratt Free Library, 400 Cathedral Street, Baltimore, MD 21201
USDA, National Agricultural Library, Beltsville, MD 20705
Dept. of Agronomy & Plant Genetics, Univ. of Minnesota, St. Paul, MN 55108
Delta Branch Experiment Station, Stoneville, MS 38776
Linda Hall Library, 5109 Cherry Street, Kansas City, MO 64110
C. Y. Thompson Library, Univ. of Nebraska, Lincoln, NE 68503
College of Agriculture & Environmental Science, New Brunswick, NJ 08903
Alburquerque Branch Library, Alburquerque, NM 87103
Albert R. Mann Library, Ithaca, NY 14850
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Plant Breeding Institute Library, Maris Lane, Trumpington, Cambridge, England
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George Forbes Memorial Library, Lincoln College, Canterbury, New Zealand
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1978 National Alfalfa Improvement Conference (NAIC)
Membership Questionnaire

Returning this questionnaire indicates that you would either like to be added to the NAIC mailing list for the period of 1976-78 or that you have an address or activity change.

1. Name: _____

2. Mailing Address: _____

_____

_____

_____

3. Office Telephone No. _____

4. Present activities with alfalfa: check most appropriate blank(s).

Research	Non-Research
1 __ Breeding	11 __ Administration
2 __ Entomology	12 __ Extension
3 __ Nematology	13 __ Forage Producer
4 __ Pathology	14 __ Marketing
5 __ Physiology	15 __ Seed Producer
6 __ Forage Production	16 __ Student
7 __ Seed Production	17 __ Teacher
8 __ Utilization	18 __ Certification and Variety Protection
9 __ Chemical and Quality Analysis	__ Other _____

5. Is it important to your activities for you to be informed of new varieties and germplasm releases ___yes, ___no.

6. If you are not able to attend the 1978 NAIC would it be important for you to receive a copy of the conference proceedings ___yes, ___no.

Note: Please call this questionnaire to the attention of your colleagues and employees who you think should be on the NAIC mailing list.

Return to: D. K. Barnes
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University of Minnesota
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